INDIAN AGRICULTURAL
RESEARCH INSTITUTE, NEW DELHI.

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PROCEEDINGS
OF THE
THIRTY-SIXTH
INDIAN SCIENCE CONGRESS
ALLAHABAD, 1949.

Published by the Indian Science Congress Association,
1, *Park Street, Calcutta,* 16
1949.

NOTE

The Proceedings are issued in four parts as follows:--

Part I.—List of officers, Proceedings of the Opening Meeting (except the General Presidential Address) and all official Matters	1 to 79
Part II.—Presidential Addresses	1 to 230
Part III.—Abstracts of Papers	1 to 245
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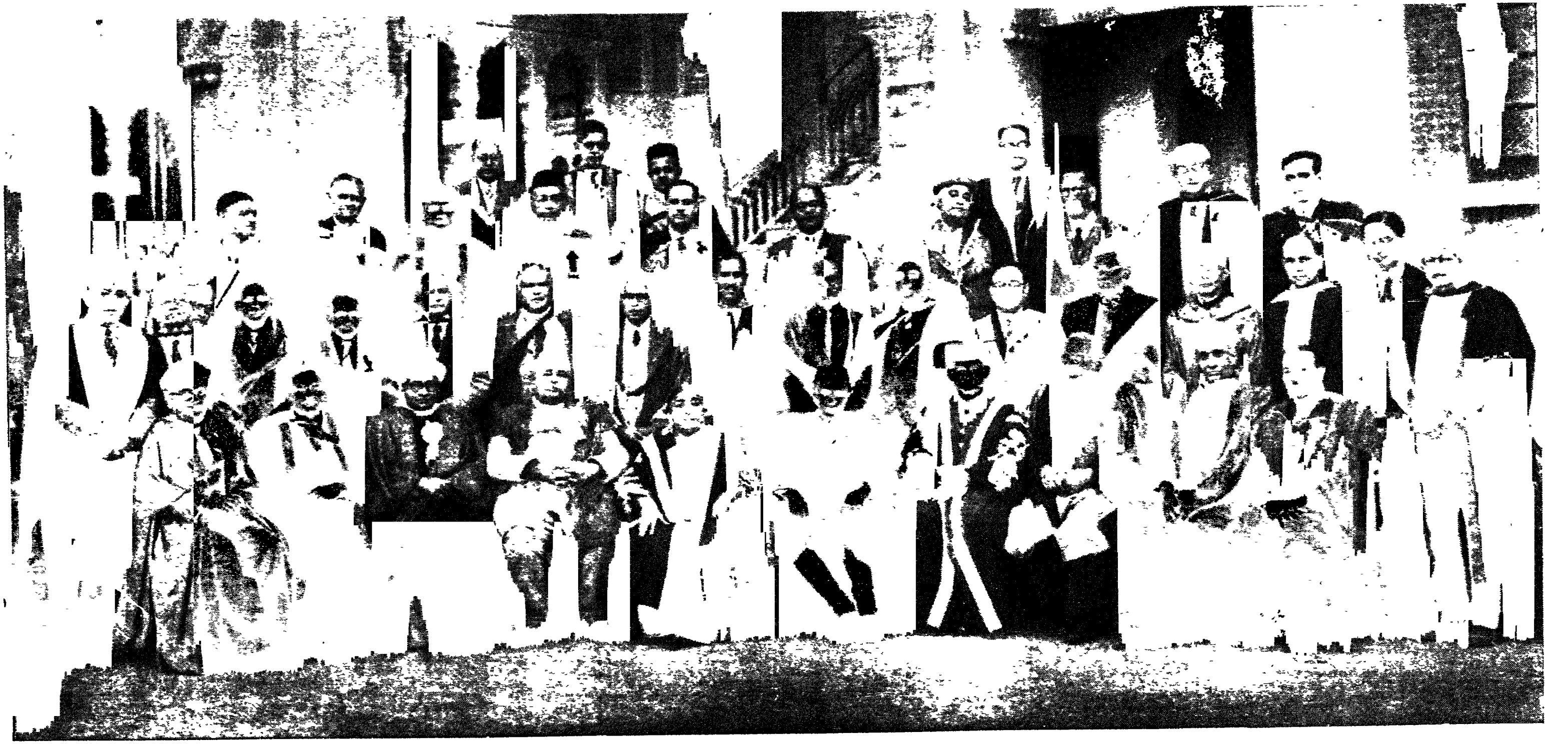
The pages numbered Part by Part (as given above for this volume), and each Part has an abstract for contents at the beginning. A complete index is given at the end of Part IV.

INDIAN SCIENCE CONGRESS.

36TH ANNUAL SESSION, ALLAHABAD 1949.



From left to right—Sitting on chairs :—Dr. B. Sanjiva Rao. Sir J. C. Ghosh. Sir K. S. Krishnan. Hon'ble Pt. G. B. Pant. H. E. Smt. Sarojini Naidu. Hon'ble Pt. Jawaharlal Nehru. Dr. D. R. Bhattacharya. Dr. Shri Ranjan. Sir C. V. Raman. Sir S. S. Bhatnagar.

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PROCEEDINGS
OF THE
THIRTY-SIXTH
INDIAN SCIENCE CONGRESS
ALLAHABAD, 1949.

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INDIAN SCIENCE CONGRESS

ALLAHABAD—1949.

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14.	Dr. K. Venkataraman, D.Sc., F.I.C., A.M.I. Chem.E.	
15.	Dr. W. D. West, M.A., Sc.D., F.N.I.	
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(f) Elected by General Committee

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[illegible]5. Dr. B. C. Basu, D.Sc.
[illegible] Capt. R. N. Basu, M.Sc., M.B., I.M.S.
[illegible]. Dr. H. J. Bhabha, Ph.D,, F.R.S., F.N.I.
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Prof. P. N. Das Gupta ..	*Recorder.*
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Dr. P. L. Shrivastava ..	*Local Sectional Secretary.*
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*Dr. Ram Behari	
Dr. D. D. Kosambi	
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Prof. K. B. Madhava	*Past Presidents of Statistics Section.*
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*Mr. S. N. Roy	
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*Dr. P. K. Bose	

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Mr. M. M. Chakravarty	
Dr. P. Sen	
Dr. K. B. Lal	
Dr. M. L. Bhatia	
Mr. D. Ganguli	
Dr. D. V. Bal	

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Mr. S. C. Kala	*Local Sectional Secretary.*
Mr. Satyendra Prasad Roy	*Elected Members.*
Mr. Anil Chowdhury	

Prof. P. C Mahalanobis	*Past Presidents who are either Ordinary or Honorary Members.*
Dr. J. H. Hutton	
Dr. B. S. Guha	
Prof. K. P. Chattopadhyay	
Dr.* G. S. Ghurye	
*Dr. D. N. Mojumdar	
*Mr. T. C. Das	
Dr. M. S. Krishnan	
Dr. N. P. Chakravarti	
*Dr. A. Aiyappan	
*Dr. (Mrs.) Irawati Karve	
Mr. A. Chatterjee	
Dr. G. M. Kurulkar	*Past Recorders who are either Ordinary or Honorary Members.*
Capt. R. N. Basu	
Mr. T. C. Roy Chowdhuri	
Mr. D. Sen	
Dr. J. K. Bose	
Dr. N. Datta-Majumdar	
Dr. H. D. Sankalia	
Dr. P. C. Biswas	

9. Medical and Veterinary Sciences

*Dr. M. B. Sobarwar	*Convener.*
Dr. Harendra Nath Ray	*Recorder.*
Dr. D. Panja	*Sectional Correspondent.*
Dr. P. Ghosh	*Local Sectional Secretary.*
Dr. A. K. Bose	*Elected Members.*
Dr. J. C. Ray	
Sir R. N. Chopra	*Past Presidents who are either Ordinary or Honorary Members.*
Lt.-Col. S. S. Sokhey	
*Mr. A. C. Ukil	
*Dr. C. G. Pandit	
Prof. K. V. Krishnan	
Dr. S. W. Hardikar	
Rai Bahadur K. N. Bagchi	
*Prof. G. Panja	
*Dr. G. D. Bhalerao	
Dr. Phanindranath Brahmachari	*Past Recorders who are either Ordinary or Honorary Members*
Mr. M. R. Mahajan	
Prof. G. Sankaran	
Mr. D. V. S. Reddy	
Dr. M. V. Radhakrishna Rao	
Dr. S. K. Basu	

10. Agricultural Sciences

Dr. R. S. Vasudeva ..	*Convener.*
Mr. P. C. Rakeja ..	*Recorder.*
Mr. E. A. R. Banerjee ..	*Sectional Correspondent.*
Dr. T. A. Mosher ..	*Local Sectional Secretary.*
Dr. J. S. Patel ..	*Elected Members.*
Dr. S. C. Roy ..	
Sir T. S. Venkataraman ..	*Past Presidents who are either Ordinary or Honorary Members.*
Prof. M. Afzal Hussain ..	
Mr. A. K. Y. Narayan Aiyer ..	
Dr. B. Viswanath ..	
Rao Sahib T. V. Ramakrishna Ayyar ..	
Prof. Jai Chand Luthra ..	
Mr. K. Ramiah ..	
Rao Bahadur Y. Ramchandra Rao ..	
Dr. D. V. Bal ..	
Prof. N. V. Joshi ..	
Rao Bahadur Y. Ramanatha Ayyar ..	
Mr. N. L. Dutt ..	
Rai Bahadur Kalidas Sawhney	
Dr. S. V. Desai ..	*Past Recorders who are either Ordinary or Honorary Members.*
Dr. A. N. Puri ..	
Dr. C. N. Acharya ..	
Dr. J. K. Basu ..	
Dr. T. V. Sukhatme ..	
Dr. B. L. Chona ..	
Dr. S. P. Ray Chaudhuri ..	

11. Physiology

Prof. B. B. Sarkar ..	*Convener.*
Prof. N. P. Benawari ..	*Recorder.*
Dr. N. N. Das ..	*Sectional Correspondent.*
Dr. K. D. Vyas ..	*Local Sectional Secretary.*
Dr. Sachidananda Banerjee ..	*Elected Members.*
Prof. S. K. Sen ..	

Prof. W. Burridge	*Past Presidents who are either Ordinary or Honorary Members.*
Lt.-Col. S. L. Bhatia	
Sir R. N. Chopra	
*Prof. N. M. Basu	
*Dr. B. B. Dikshit	
Rao Bahadur B. T. Krishnan	
Prof. B. Narayana	
*Prof. S. N. Mathur	
*Dr. B. Mukerji	
Prof. P De	
*Prof S. A. Rahman	
*Dr. Bashir Ahmad	
Mr. K. Mitra	*Past Recorders who are either Ordinary or Honorary Members.*
K. P. Basu	
Mr. B. Chatterji	
Prof. Khem Singh Grewal	
Mr. M. L. Chatterjee	
Prof. G. K. Ghosh	
Mrs. Kamala Sohoney	

12. Psychology and Educational Science

*Prof. T. K. N. Menon	*Convener.*
Prof. Kali Prasad	*Recorder.*
Mrs. Santa Deb	*Sectional Correspondent.*
Dr. (Lt.-Col.) Sohan Lall	*Local Sectional Secretary.*
Mrs. Mamata Chowdhury	*Elected Members.*
Mrs. Bani Chatterjee	
Mr. N. S. N. Sastry	*Past Presidents who are either Ordinary or Honorary Members.*
Prof. G. S. Bose	
Dr. S. C. Mitra	
Mr. J. M. Sen	
Mr. K. C. Mukherji	
Prof. H. P. Maiti	
Dr. I. Latif	
*Dr. G. Pal	
Prof. B. L. Atreya	
*Dr. B. Kupuswamy	
*Dr. Indra Sen	
Mr. P. S. Naidu	
Dr. Zakir Husain	

Mr. S. K. Bose	..	*Past Recorders who are either Ordinary or Honorary Members.*
Mr. S. Sinha	..	
Mr. Pars Ram	..	
Dr. Miss. K. H. Cama		

13. **Engineering and Metallurgy**

Prof. M. Sen Gupta	....	*Convener.*
Mr. J. Ganguly	..	*Recorder.*
Dr. J. N. Basu	..	*Sectional Correspondent.*
Mr. D. H. R. Rao	..	*Local Sectional Secretary.*
Mr. J Dutta Esqr.	..	*Elected Members.*
Dr. D. R. Malhotra	..	
*Dr. A. H. Pandya	..	*Past Presidents who are either Ordinary or Honorary Members.*
Mr. N. V. Modak	..	
Sir Jehangir Ghandy	..	
Rai Bahadur A N. Khosla	..	
Mr. P. H. Kutar	..	
Mr. H. P. Bhaumik	..	
*Mr. N. Sen	..	
Prof. H. L. Roy	..	*Past Recorders who are either Ordinary or Honorary Members*
Dr. S. K. Sircar	..	

Sub-Committee on Science and its Social Relations:—

1-4. President, two General Secretaries and Treasurer (*ex-officio*)
1-17. Sectional Presidents of 13 Sections.
18. Dr. S. P. Agharkar (Bombay).
19. Dr. K. N. Bagchi (Calcutta).
20. Prof. H. J. Bhabha (Bombay).
21. Dr. G. D. Bhalerao (Izatnagar).
22. Dr. Gilbert J. Fowler (Bangalore).
23. Dr. B. C. Guha (Calcutta).
24. Prof. D. D. Kanga (Adyar).
25. Prof. H. P. Maiti (Patna).
26. Dr. H. K. Mitra (Jamshedpur).
27. Dr. K. Motwani (Adyar).
28. Prof. M. N. Saha (Calcutta)
29. Prof Benoy Kumar Sarkar (Calcutta).
30. Rai Bahadur K. D. Sawhney (Hyderabad).
31. Rai Bahadur J. M. Sen (Calcutta)—**Convenor.**
23. Sir S. S. Sokhey (Bombay).
33. Dr. A. C. Ukil (Calcutta).
34. Dr. D. N. Wadia (New Delhi).

4. LOCAL RECEPTION COMMITTEE

Patron

Her Excellency Shrimati Sarojini Naidu, Governor of U. P.

Chairman

Hon'ble Pt. Govind Ballabh Pant, Premier, U. P.

Vice-Chairman

The Hon'ble Shri Bidhu Bhusan Mallik, Chief Justice.

The Hon'ble Shri Sampurnanad, Educational Minister, U. P.
Dr. D. R. Bhattacharya, Vice-Chancellor, Allahabad University
Sir Padampat Singhania, Kanpur
Shri M. R. Jaipuria, Swedeshi Cotton Mills Limited, Kanpur
Shri R. P. Bhargava, I.C.S., Collector & Magistrate, Allahabad
Pandit J. P. Tripathi, President, Court of Wards, U. P.

Local Secretaries

Dr. Shri Ranjan, M. Sc., Docteur-es-Sciences, F. A. Sc.
Prof. Saligram Bhargava, M. Sc.

Members

The Hon'ble Mr. Justice P. N. Sapru
The Hon'ble Mr. Justice O. H. Mootham
The Hon'ble Mr. Justice Raghubir Dayal
The Hon'ble Mr. Justice K. N. Wanchoo
The Hon'ble Mr. Justice Bind Basni Prasad
Shri S. C. Varma
„ D. K. Wahal
„ Lakshman Prasad
Dr. B. K. Mukerji
Shri J. Sahai
Messrs. Scientific Instrument Co. Ltd.
Shri Niranjan Lal Bhargava
„ Hari Ram Agarwal
Dr. M. H. Faruqi
Shri Rai Amarnath Agarwal
Major S. N. Kaul
Shri R. C. Agarwala, Bari Kothi, Daragunj
Mohd. Abdulla Kadir, 20, Canning Road
Rana Prakram Jung Bahadur, Phaphamau Castle, Allahabad
Mahadeo Prasad & Sons
G. P. Tandon, Esq
Mr. D. D. Seth
Shri J. N. Takru, Advocate, 12, Tej Bahadur Sapru Road, Allahabad
Capt. M. P. Sharma, 18B Elgin Road, Allahabad
The Hon'ble Mr. Justice Harish Chandra, I.C.S.
Shri A. K. Mustafi, I.A.S., Clive Road, Allahabad
„ Balgovind Das, Proprietor, Lallooji & sons, Allahabad
„ Parisadh Narain Anad, M.L.C., Allahabad
„ C. P. Srivastava, 26, Jawaharlal Nehru Road, Allahabad
Rai Bahadur Damodar Das, Collector of Central Excise, Allahabad
Shri Sitaram Agarwal, Sugar Mills, Naini
„ A. C. Gupta, Secretary, Oriental Life Insurance Co.

5. ARRANGEMENTS FOR THE THIRTY-SIXTH SESSION

The local Reception Committee made all local arrangements necessary for the transaction of the scientific work of the session as well as for the accommodation of members and delegates who attended the session.

6. LIST OF DELEGATES

FOREIGN

United States

Dr. Charles Burlingame, Psychologist, America.
Mr. Govind Behari Lal, Science Editor, Hearst Newspapers, America.
Prof. S. Chapman, Geophysicist, Great Britain.

University of Kabul

Dr. B. K. Kar.

University of Rangoon

Prof. Aung Hla.
Dr. Mg. Mg. Kha.
Dr. B. Than.
Dr. Mg. E.
Dr. Uko Lay.
Dr. Hla Kyaw.
Dr. Tha Hla.

LEARNED SOCIETIES

The National Academy of Science, India..	Prof. Sir K. S. Krishnan.
	Prof. Ram Behari.
	Prof. Sir. S. S. Bhatnagar.
	Prof. K. N. Bahl.
	Prof. Birbal Shani.
	Prof. J. M. Sen.
	Prof. R. K. Asundi.
	Prof. K. C. Mehta.

Calcutta Mathematical Society ..	Prof. A. C. Banerjee. Dr. B. B. Sen. Dr. Gorakh Prasad. Mr. S. Gupta. Mr. A. C. Chowdhury.
Indian Association for the Cultivation of Science.	Dr. K. Banerjee. Dr. S. C. Sarkar. Prof. Santi R. Palit.
Indian Pharmaceutical Association Benares, ..	Prof. N. K. Basu. Mr. D. N. Majumdar. Mr. B. V. Palit. Mr. P. Das. Dr. B. Bhatia. Mr. K. C. Chatterjee.
Indian Research Fund Association ..	Dr. C. G. Pandit.
National Institute of Science ..	Sir S. S. Bhatnagar.
Indian Chemical Society ..	Dr. J. K. Chowdhury. Dr. S. S. Joshi. Dr. T. R. Seshadri. Dr. K. C. Sen.
Indian Botanical Society ..	Prof. B. Sahni. Prof. G. P. Mazumdar. Dr. T. S. Mahabale.
Royal Institute of Science, Bombay ...	Prof. B. Sahni. Prof. G. P. Majumdar. Dr. T. S. Mahabale.
Indian Medical Association ..	Dr. A. C. Ukil. Dr. B. Mukerji. Dr. A. K. Sen.

The Institute of Engineers (India)	Rai Bahadur N. K. Mitra.
	K. C. Gupta.
	Mr. M. P. Mathrani.
	Rai Bahadur A. C. Mukerjee.
	P. C. Agarwal.
	H. C. Trivedi.
	Dr. K. C. Chakko.
	Mr. K. B. Ray.
	Mr. J. Dutta.
	Rai Bahadur M. C. Gupta.
	Mr. K. N. Chattopadhya.
	Mr. J. Ganguly.

UNIVERSITIES

Andhra University	Prof. A. Narasingha Rao.
	Dr. T. Venkatarayudu.
	Prof. T. R. Seshadri.
	Dr. S. Minakshisundaram.
	Dr. M. Narasinga Rao.
	Prof. N. K. Sur.
	Dr. N. S. Subba Rao.
	Mr. K. Nagabhushanam.
	Prof. C. Mahadevan.
	Mr. B. Sarveswara Rao.
Annamalai University	Prof. G. V. Krishnaswami Ayyangar
	Dr. K. C. Chakko.
	Dr. M. U. Pai.
Bombay University	Dr. D. D. Karve.
	Dr. K. Venkataraman.
	Dr. H. J. Bhabha.
	Mr. M. C. Chakrabarti.
Calcutta University	Prof. S. N. Bose.
	Prof. P. Ray.
	Dr. D. Chakravorty.
	Prof. H. K. Mookerjee.
	Prof. P. C. Sarbadhikari.

	Prof. N. R. Sen. Mr. N. K. Bose. Mr. M. N. Basu. Mr. P. K. Bose. Mr. H. K. Nandi.
Delhi University	Dr. R. C. Majumdar. Dr. S. Dutta. Dr. Ram Behari. Dr. F. C. Auluce. Dr. R. P. Mitra. Dr. J. Shankar. Dr. P. C. Biswas. Dr. N. K. Shaha. Dr. J. J. Chinoy. Dr. B. M. Joshi. Dr. P. L. Bhatnagar. Miss. Hilda Raj. Mr. K. Gopalakrishnan.
Gauhati University	Dr. H. K. Baruah. Prof. V. D. Thawani.
Lucknow University	Prof. Kaliprasad. Shri R. M. Loomba. Prof. Shyam Narain Mathur. Dr. D. N. Mazumdar. Shri H. S. Asthana.
Madras University	Shri B. B. Dey. Shri M. A. Govinda Rao. Shri L. A. Krishna Ayyar. Shri G. D. Boay. Shri D. V. Rajalakshman. Shri George K. Kuriyan.
Muslim University, Aligarh ..	Mr. T. M. P. Arbuthnot. Dr. N. M. Basu. Dr. S. M. Ali.

	Dr. S. M. Tahir Rizvi.
	Dr. M. A. H. Qudri.
	Dr. M. M. Tarooq.
Nagpur University	Dr. S. A. Saletore.
	Dr. M. C. Nath.
	Dr. R. L. Nirula.
	Dr. K. Krishnamurti.
	Dr. P. S. Mene.
	Shri K. Sripada Rao.
	Shrimati S. Chitaby.
	Dr. M. A. Moghe.
Osmania University, Hyderabad, Deccan	Dr. B. K. Das.
Utkal University, Cuttack	Dr. B. Prasad.
	Dr. S. S. Guha Sircar.

RESEARCH INSTITUTIONS AND COLLEGES

National Physical Laboratory	Mr. V. Kadambe.
	Dr. Swami Jnanananda,
	Mr. Mohanlal Khanna.
	Miss. Tharakan.
	Dr. A. S. Bhatnagar.
Forest Research Institute and College, Dehra-Dun	Dr. S. Krishna.
	Dr. G. S. Kasbekar.
	Dr. V. Ranganathan.
	Dr. G. S. Puri.
	Dr. K. R. Nair.
	Mr. K. Ramish Rao.
	Shri K. N. Tandon.
Jaswal College, Jodhpur	Mr. Santi Swarup.
	Mr. I. C. Gaur.
D. A V. College, Dehra-Dun	Mrs. T. Singha.
	Mr. R. P. P. Mathur.

GOVT. OF INDIA, PROVINCIAL GOVTS. AND STATES

Armed Forces, Medical Services (Govt. of India)	Lt. Gen. K. S. Masters.
	Lt. Col. G. Swaroop Narain.
	Lt. Col. P. N. Bardhan.
Ministry of Defence (Govt. of India)	Dr. D. S. Kothari.
	Mr. B. B. Ghosh.
	Mr. Wanchoo.
	Gr. Capt. M. M. Shrinagesh.
Govt. of India, Ministry of Defence, New Delhi	Maj. Gen. Kulwant Singh.
	Maj. Gen. H. Williams.
	Master General of Ordnance.
	Brig. N. D. Bilimoria,
	Dr. R. S. Thakur.
	Brig. H. G. Parcell.
	Col. C. T. Edward-Collins.
	Dr. T. S. Subramanyam.
	Col. N. N. Chopra.
Navy	Commodore H. Drew, R.N.
Air Force	Air Vice-Marshal S. Mukerjee.
	Gr. Capt. W. D. Disbrey.
	Wing Commander A. J. Henry Sathyanathan.
	Sq. Lr. M. P. Srivastava.
Ministry of Education, Govt. of India	Mr. B. B. Ghosh.
	Mr. N. N. Wanchoo.
	Mr. D. V. Krishnaswami.
	Dr. B. B. Lal.
Ministry of Health (Govt. of India)	
Central Drugs Laboratory	Dr. B. Mukherji.
Pharmacognosy Laboratory	Mr. S. C. Datta.

Govt. of India, Dept. Scientific Research	Dr. S. S. Bhatnagar.
	Dr. P. S. Gill.
Govt. of Assam	Dr. D. K. Mehra.
Govt. of West Bengal, Dept. Agriculture	Dr. K. P. Biswas.
	Shri E. A. R. Banerjee.
	Shri M. S. Das.
Dept. of Agriculture, Paradeniya, Ceylon	Dr. P. G. Malkani.
Govt. of Nepal	Prof. Shree Prakash.
Office of the Director of Public Instruction, Pondichery	Dr. G. E. Monod Herjen.
Commercial and Industries Dept., Vindya Pradesh	Mr. J. C. Gupta.
	Mr. V. N. Shrivastava.
	Mr. G. P. Khare.
Director of Education, Govt. of Jodhpur	Mr. Lakhpat Raj Shah,
Director of Education, Govt. U. P.	Dr. Satya Prakash.

COMMERCIAL BODIES

Corporation of Calcutta	Shri Kanai Lal De.
Tata Iron and Steel Company, Jamshedpur	Dr. H. K. Mitra.
	Dr. K. C. Mazumdar.
	Mr. J. M. Sinha.
	Mr. K. K. Ray Chaudhury.
	Mr. J. D. Engineer,

7. PROGRAMME OF THE SESSION.

The 36th Annual Meeting of the Indian Science Congress Association was held at Allahabad under the auspices of the University of Allahabad from January 2nd to January 8th, 1949.

The inaugural meeting was held on Monday, January 3rd, 1949, at 2 p.m. in the Senate Hall, Allahabad University, in the presence of a large number of delegates, members and visitors. Overseas scientists from Great Britain, and America, delegates from Afghanistan and Burma were present.

After the opening song *'Janaganamana Adhinayaka'*, Hon'ble Pandit Govind Ballav Pant, Premier of the United Provinces, as Chairman of the Local Reception Committee, welcomed the delegates, members and visitors and requested Her Excellency Shrimati Sarojini Naidu, Governor of U. P. and Chancellor of the University of Allahabad to open the Session of the Congress. After Her Excellency had opened the Session, Hon'ble Pt. Jawaharlal Nehru, Prime Minister, Indian Dominion, addressed the gathering.

The President of the Congress, Sir K. S. Krishnan, then delivered his Presidential Address.

Dr. Shri Ranjan, Local Secretary and Dean of the Faculty of Science of the Allahabad University, thanked Panditji for kindly consenting to inaugurate the Session in the Allahabad University and welcomed the foreign scientists, delegates and members for accepting the hospitality of the Allahabad University on the occasion. He expressed the hope that the ancient and sacred city of Allahabad would offer them enough attraction and materials for sight-seeing for the brief period of their stay. The problem of housing the large number of delegates had not been easy for the Organizing Committee and he was not unaware of their shortcomings. He hoped however that members and delegates would bear with these inconveniences cheerfully and extend their co-operation to him in making the Session a real success.

Dr. B. Mukerji, General Secretary, offered a vote of thanks on behalf of the Executive Committee of the Association individually to Hon'ble Pandit Jawaharlal Nehru, Her Excellency Shrimati Sarojini Naidu, (Chancellor), and Hon'ble Pandit Govind Ballav Pant (Chairman of the Reception Committee) for the goodwill and gesture they had shown by taking part in the inaugural ceremony of the 36th Session of the Indian Science Congress. Allahabad is the home town of Panditji and it was only in the fitness of things that he should be present in person to inaugurate the Session. The Chancellor (Shrimati Sarojini Naidu) had long been known as a great promoter of science, being the daughter of late Dr. Aghore Nath Chattopadhyaya of Bengal, who, incidentally, was the first Indian to obtain the Degree of Doctor of Science from the Edinburgh University.

Hon'ble Pandit Pant deserved the warmest thanks of the Association for the help he had rendered by consenting to serve as the Chairman of the Reception Committee in the midst of his other onerous duties. His love for science and its utilisation towards national development is well known to everybody, both in U.P. and outside it, Dr. Mukerji expressed his sincere appreciation to Dr. D. R. Bhattacharya (Vice Chancellor), Dr. Shri Ranjan and Prof. Shaligram Bhargava, (Local Secretaries), for the trouble they had taken in organising the meetings of the 13 sections of the Indian Science Congress and its 21 affiliated societies in the buildings of the University of Allahabad. The University, said Dr. Mukerji, was lucky in having a Vice Chancellor, who could be considered as a rare combination of musical and scientific talent. Not many people present on the occasion would be aware that the Vice Chancellor, whom they had known as a distinguished Zoologist and teacher, has been a pioneer organiser of all-India music competitions and that he himself and most of the members of his family are eminent musicians. The courtesy and hospitality of the Vice Chancellor had already impressed a number of delegates who had been in touch with him. Dr. Mukerji then spoke in glowing terms about the great efforts made by Dr. Shri Ranjan and Prof. Bhargava in solving the problem of housing of the rather large number of delegates, who attended the Session. While it was a source of encouragement to him that there had been such a welcome response from the delegates, he confessed he was anxious about the availability of accommodation at Allahabad. The tremendous amount of organising work which the Local Secretaries had to undertake however, made it possible for the Session to start its work smoothly. In these days of scarcity, it was no mean achievement to be able to cater to the housing and other needs of over 1200 delegates. He warmly complimented the Local Secretaries and the experienced team that worked with them and sympathised with them for the sleepless nights they had to spend in this connection.

After '*Bandematavam*' was sung by a chorus of university girls, members and visitors all standing, the inaugural session terminated.

SECTIONAL PRESIDENTIAL ADDRESSES

The Presidential Addresses of the Sections were delivered as follows:

Tuesday, January 4th: 10 a.m.—Zoology and Entomology; 10-30 a.m.—Statistics; 11 a.m.—Anthropology and Archaeology; 11-30 a.m.—Physics; 12 noon—Psychology and Educational Sciences.

Wednesday, January 5th:—10 a.m.—Physiology; 11 a.m.—Agriculture; 11-30 a.m.—Geology and Geography; 12 noon—Chemistry.

Thursday, January 6th:—10 a.m.—Mathematics; 10-30 a.m.—Medical and Veterinary Sciences; 11 a.m.—Botany; 12 noon—Engineering and Metallurgy.

Symposia and Joint Discussions were held as follows:—

SUBJECT	SECTION
Tuesday, January 4, 1949.	
1. "The Importance of Ecological studies of plants in Agriculture"	Agriculture and Botany.
2. Divergent Series	Mathematics.

SUBJECT	SECTION
3. "The Role of National Bureau of Mines in the Development of Mineral Industry" ..	Geology.
4. Psychological and Educational approach to Languages ..	Psychology and Educational Sciences.
5. "Species formation in Animals and Plants" ..	Zoology, Entomology and Botany.
6. "Training in India for Professional Careers in the Field Sciences" ..	Geology and Geography, Botany, Zoology and Entomology, and Anthropology and Archaeology.
7. Indian Coal and its utilisation ..	Chemistry.
General Symposium on "Application of Science in Free India for Social Welfare" ..	Sub-Committee on Science and its Social Relations.
Wednesday, January 5	
1. Symposium on "Cosmic Rays" ..	Physics.
2. Earliest Indications of Mental Symptoms ..	Section of Medical and Veterinary Science and Psychology and Educational Sciences in collaboration with Indian Psychiatric Society.
3. Census Methods ..	Statistics.
4. Preparation of National Atlas ..	Geology and Geography.
5. "Electro Chemical Properties of Clay and Clay Minerals" by Dr. J. N. Mukherjee ..	Chemistry.
6. Symposium on "Stellar Constitution" ..	National Institute of Sciences of India.
Thursday, January 6.	
1. Chemistry of Products ..	Chemistry.
2. Discussion on "Upgrading of Physiological Teaching in Medical Science Curricula" opened by Dr. B. B. Sarkar and Dr. R. Viswanathan ..	Sections of Physiology, Medical and Veterinary Science.
3. Post—Graduate Teaching of Statistics ..	Statistics.

SUBJECT	SECTION
Friday January, 7.	
1. High Polymers ..	Chemistry.
2. Statistical Physics ..	Statistics and Physics.
3. Patent System	
4. "Joshi Effect" (Chemistry) ..	Physics and Chemistry.
5. Symposium on "Question of Teaching Sciences in Indian Languages and the Problem of Scientific Terminology" under Vigyan Parishad, Allahabad ..	Vigyan Parisad, Allahabad.
Discussion on "Nutritive value of Rice" ..	Physiology.

MEETINGS OF COMMITTEES

The Council met on January 4 at 5-15 p.m.

The Executive Committee met on January 2 at 3 p.m. and on January 5 at 4-30 p.m. and again on January 6 at 9-30 a.m.

The Sub-Committee on Science and its Social Relations met on January 2 at 6 p.m.

The Sectional Committees met on January 4, 5, 6 and 7 at 9-30 a.m.

The General Committee met on January 6 at 2-30 p. m.

SOCIAL FUNCTIONS

January 2:—'At Home' by Her Excellency the Governor at Government House Lawns, at 4-30 p. m.

January 3:—'At Home' by the Members of the Reception Committee in the Muir College Grounds at 4-30 p. m.

January 4:—'At Home' by the Allahabad Uuniversity in the Muir College Grounds at 4-30 p. m.

January 5:—'At Home' by Indian Pharmaceutical Association at 4-30 p. m.

January 6:—Variety Programme by Culture Centre, Allahabad at 6 p. m. in the Senate Hall.

POPULAR LECTURES

January 4:—'Polar Lights' by Prof. S. Chapman

January 5:—'Defence Science' by Dr. D. S. Kothari,

Make Science Possession of Common Man' by Sri Govind Behari Lal (America).

January 6:—'Mahatma's Dandi March' by Sir C. V. Raman

January 7:—"Economics of Psychiatry" by Dr. C. Charles Burlingame
"Age of the Earth" by Prof. F. E. Zeuner.

WHOLEDAY EXCURSIONS

January 9:—Kausambi and Mirzapur.

The 36th Science Congress Week, Allahabad
1st to 8th January, 1949

PROGRAMME

Saturday, January 1, 1949

Annual Meeting of the National Academy of Sciences (India).

Sunday, January 2, 1949

Meeting of the National Institute of Sciences.

Discussion regarding the formation of a National Committee for India to co-operate with the International Union of the History of Science.

Annual Meetings:—

Benares Mathematical Society.
Society of Biological Chemists (India).
All India Nutrition Board.
Indian Psychiatric Society.
Indian Society of Soil Science.
Indian Ecological Society.
Indian Association of Micro-biologists.
Indian Institute of Chemical Engineers.
Institution of Engineers (India).
Indian Phytopathological Society.
Royal Institute of Chemistry of Great Britain and Ireland. Indian Section.
Helminthological Society of India.
Indian Association for the Advancement of Science.

Annual Meetings of:—

Indian Botanical Society.
Indian Physical Society.
Indian Psychological Association.
Indian Zoological Society.
Indian Pharmaceutical Association.
Indian Academy of Zoology.
Institution of Chemists (India).
Indian Ceramic Society.
Physiological Society of India.
Museum Association of India.

Association of Indian Geographers.
Indian Society of Genetics and Plant Breeding.
Council Meeting of the Indian Chemical Society.
Meeting of the Executive Committee of the Science Congress Association.
Meeting of the Council of the Science Congress Association.
Meeting of the Sub-Committee on Science and its Social Relations.
Meeting of the U. P. Scientific Research Committee.

Monday, January 3, 1949

Committee Meetings of the National Institute of Sciences.
Silver Jubilee Celebratian of the Indian Chemical Society.

Inaugural meeting: Welcome speech, opening of session, Congress President's address.

Popular Lecture by Dr. H. J. Bhaba.
Popular Lecture by Sir J. C. Ghosh.
DINNER (by invitation).

Tuesday, January 4, 1949

Annual Meeting of Association of Scientific Workers.
Annual Meeting of the National Institute of Sciences of India.
Indian Chemical Society—Annual General Meeting.
Annual Meeting of the Entomological Society of India.

8. OPENING PROCEEDINGS.

Hon'ble Pandit Govind Ballabh Pant, Premier, U. P., and Chairman, Reception Committee delivered the following welcome address on Jan. 3rd, 1949 :—

It is my privilege to offer you a very warm and cordial welcome on behalf of the Reception Committee, the U. P. Government and my own. We are specially beholden to the eminent scientists who have come here from across the seas.

The news of the selection of Allahabad as the venue of the Session of the Congress was hailed by all of us. Allahabad is the intellectual centre of our province. It is an ancient city and has been celebrated for its learning and scholarship from before the dawn of history. It has been prominently mentioned in the legends of our country and its cultural roots have been firmly and deeply laid. Just close to this very place we have the *ashram* of *Muni Bharadwaj*, believed to have been founded long before the commencement of the Christian era. The invisible stream of knowledge, *Saraswati*, named after the Goddess of Learning, takes its birth here at *Prayag* at the confluence of *Ganga* and *Jamuna*, giving fresh impetus to learning and inspiration to its votaries. *Prayag* is also known as *Tirthraj*, the most esteemed centre of pilgrimage. It attracts a huge concourse of people every year. Hieu-en-Tsang attended one of these gatherings about thirteen hundred years ago and his account of what he observed bears testimony to the high cultural level attained by the people of this land even in those days of isolation. Allahabad has maintained its traditions and has the honour of being the home of the first Prime Minister of free India who is happily in our midst here to-day. The

Allahabad University occupies a place of honour in the academic world and it has throughout given first place to the study of natural sciences. The Government as well as the University authorities fully realize the importance of scientific study and research and are anxious to make a concerted effort in that direction so that this university may not lag behind any other in this important matter.

It is difficult to form a measure of the value and utility of science in the present age. Science has enabled man to acquire complete mastery over matter. Nature stands subdued and conquered; the so-called Laws of Nature are no longer permanent and immutable, defying human oontrol. Man, with the aid of science, has dominated them. Matter has ceased to be material; what were believed to be elements, fundamentally different from one another in the ultimate analysis, have shed their individuality. The alchemist's dream has come to be true; the atom has been split up releasing tremendous possibilities for the good and advancement of mankind; even the principle of causality is no longer ensconced in a secure seat; mind has scored a triumph over matter.

Science has wrought miracles and has expanded its activities so as to influence every aspect of life. We in this country, however, still lag behind many others in this respect. In the past, owing to the unnatural conditions prevailing in our country, it was perhaps difficult to make an earnest sustained effort for the propagation of science and the application of its discoveries in an adequate and satisfactory manner. We have now to make up for the accumulated arrears of long years of neglect under alien domination so that poverty and disease, illiteracy and superstition may be wiped out and the average citizen may fully enjoy life, liberty and happiness without any let and hindrance. With our immense man-power and vast resources which have not yet been tapped even superficially, it should not take us long to achieve our social objective, provided we proceed on a scientifically-planned basis. We look to assemblies such as this Congress for harnessing all constructive talent, thought and energy so that the pace of progress may be accelerated. I am particularly glad to welcome you to this Session as I believe that in new India there is unlimited scope for real growth and development and that men of light and learning can give a fresh impulse and a healthy stimulus to all progressive forces in their efforts to establish a new order based on human dignity, social justice and equality of opportunity. The Government of India has taken up the work of scientific research in right earnest and is setting up a number of well-equipped institutes for this purpose in various parts of the country.

Science has a still higher purpose. Apart from the material benefits that it has conferred upon humanity it has given a wholesome bias to human thought. It fosters a rational outlook and instals reason in its rightful pedestal. It works as a powerful unifying force, knows no geographical limits and makes no distinction between man and man. It has broken all barriers and even demonstrated the unity of all life. It exerts a powerful influence in giving the right tone and discipline to human mind and places the quest of truth above all other considerations. The spirit of science is ever one of robust optimism; it knows and accepts no defeat. It hankers for no material or other reward. It finds joy and zest in the indefatigable pursuit of its enquiries, enabling man to climb higher and higher in the ladder of truth. Let us hope that the eternal verities which intuition revealed to the seers thousands of years ago will be reinforced and demonstrably established so that all strife and dissension may cease, amity and harmony be restored and human fraternity and brotherhood in the material as well as the spiritual world be firmly established. Science has opened out the vast realms of knowledge and the pursuit of truth should in its maturity reveal wisdom in its unalloyed purity so that man may not err and falter in realizing his destiny."

Governor's Address

Her Excellency the Governor, Shrimati Sarojini Naidu, after Pandit Govind Ballabh Pant's speech, offered a warm welcome to the delegates to the Science Congress and endorsed his tribute to the Allahabad University for its devotion to science. She said, it was right and proper that the first Congress of Science to be held in Free India should be in the birthplace of the scientist and the architect of freedom, Pandit Jawaharlal Nehru.

If men of science resolved in one great brotherhood and in one noble fraternity to conquer the forces of evil in the world and tame them for the good of humanity and if they refused to utilise their knowledge for the destruction of humanity at the bidding of dictators and tyrants, they would render a great service to the world. Mrs. Naidu said she was confident that the great galaxy of scientists present there were determined to serve the cause of righteousness.

Requesting Pandit Jawaharlal Nehru to inaugurate the Session of the Science Congress, Mrs. Naidu said he was a great crusader for ideals and also a practical statesman. He had sacrificed his all for national freedom and was ready to sacrifice all again for international co-operation and friendship. He would see that science came into the full heritage of its power to serve humanity. (Applause).

Pandit Nehru's Inaugural Address*

Pandit Jawaharlal Nehru said: You have been welcomed by the Governor and by the Premier of this province and I have come here on behalf of the Government of India to bid you a warm welcome to this Science Congress and to assure you, if an assurance is needed, of our interest in your work and achievements. I am also here in my personal capacity as a citizen of Allahabad to express my pleasure at the meeting of this distinguished Congress in my home-town of Allahabad. (Applause). Reference has been made to this city as a centre of intellectuality and as a place where for ages past people came for learning and also as a place where people come to die. (Laughter). When these compliments are paid to this city of Allahabad I do not take them at their face value. So far as the question of dying is concerned, I prefer to live in a place where people go to live and not to die. But when Allahabad is said to be the seat of intellectuality, it almost leads me to think that it has no other claim left having been deprived of most of the other things that originally belonged to her. Fortunately, the University is still there in Allahabad and presumably will continue. Fortunately, the rivers *Ganga* and *Jamuna* are also here and presumably will continue. (Laughter). Therefore, in the final analysis, the citizens of Allahabad need not despair and so long as we have *Ganga* and *Jamuna* we can carry on.

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* Edited from Stenographer's Notes.

Pandit Nehru then paid his tribute to one of the most eminent Indian scientists whom they were happy to see amidst them, Dr. C. V. Raman, who had recently celebrated his 60th birthday. (Applause). Sixty years was not very much in a man's life and they hoped that he would be spared for many more years of service in the cause of science and in the cause of India. (Applause).

Proceeding, Pandit Nehru said that undoubtedly science had done tremendous good for the world and in India, they had to concentrate on the advancement of scientific research and the application of science. The Government was building up laboratories, institutes, and the like to give opportunities to their youths to further the cause of science, because they realised that a country must be good in regard to scientific research and application of science, if it was to play its proper part in the world and because they also realised that they could not solve their problems, economic or otherwise, without the help of science. Science must progress and they, as a Government, were certainly going to do their utmost to give it the opportunity to progress. After all, they could only give the opportunity but ultimately it was the human being who counted in the institute and not the money which flowed in to it from the Exchequer. If India had human beings of the right calibre who could take advantage of these opportunities, it would be well and good. He was quite convinced that many of their younger men in the scientific field were of the right calibre and were bound to make good, if they were given the opportunities.

Pandit Nehru said that he had come to think that quality was far more important than quantity in scientific knowledge. It was true that out of quantity came quality, or the opportunity came if the masses of India had sufficient opportunities for their training and he had no doubt that a vast number of competent, able and talented young men and women would come out in every field of activity and more especially in science. Giving them opportunity was where quantity came in, but if they were content with quantity only then he feared they would remain secondary in the field of science. Therefore, quality became essential and he laid stress on this because he feared that during the past two or three years when they talked so much on scientific advance they had laid stress on quantity more than on quality.

As he had said the other day at Bangalore, Pandit Nehru was not satisfied with the quality and output in India in the field of science. Frankly speaking, he thought that they were not quite so big in the scientific field as they said they were. Somehow they were getting lost in smaller things, in mutual debates and arguments and not concentrating on that type of scientific work which was of a basic nature and out of which all other types of scientific activities grew. He liked to see more fundamental work and less of what he might call rather superficial work, in fact, more of that spirit of true science which should animate and inspire them and lead them to bigger achievements.

Pandit Nehru said that the problems they had to face in the world and in India today were overwhelming. In India the economic problem was dominant and they had to think of ways to solve it. Unfortunately; even the cause of science was suffering in India because of their economic difficulties.

The economic problem was a big one and it was not directly concerned with their work in the Science Congress. What should scientists do and to what end should they work?

Dealing with this question, Pandit Nehru said that obviously the men of the highest calibre must be given a chance to work as they chose and it was no good third-rate men trying to do the work of first-rate men. Really, first-rate men in the field of science and indeed in any field must be given a fair amount of latitude to do just what they liked. They might fail or they might succeed, but if they are not given this latitude, they might miss something very great. The problem that troubled him was how, in the final analysis, science was helping them today in the solution not of the thousand and one problems of the world but of what he would call the one single fundamental problem of this world. In spite of its very great scientific achievement today, the world was obviously in a bad way and there was something very wrong about it. There were plenty of men of ability and talent and even genius, plenty of men of goodwill and yet the world went wrong.

What were they going to do about it? People said they were in an age of transition, but every age was an age of transition. What did men of science propose to do about it. Whether they were scientists or not, they could not escape the consequences of this conflict of spirit that was going on all over the world and certainly in India. He did not think that mere scientific advance, however great it might be, gave the answer to this major problem. Indeed, scientific advance rather intensified that problem unless they found some other ways and means of solving it. The shake-up of the world, when industrial civilization began about 200 years ago had continued in varying degrees. As soon as places where industrialisation had not spread became fewer and fewer, the crisis became more and more acute. It led to the First World War, which led again in a more acute form to the Second World War and today it was leading to some frightful catastrophe. The lack of adjustment caused by industrialisation spreading and not being properly balanced with other conditions, had led to the crisis that enveloped them. The odd thing was that scientists added to that crisis by finding out more and more ways of advance in this particular field. Unless the scientist found out ways of balancing that advance, he added to the crisis and the result was that he sped the possible destruction of his own work in a big way.

How exactly any scientist was going to deal with this tremendous problem he did not know, said Pandit Nehru. A scientist, like any other person must develop some kind of organic knowledge of human history and human advance. He must develop some perspective and try to see how things had developed, how humanity had been affected in its various phases of existence, how it was profited by science and how it had not profited, not because of lack of science but because of a lack of adjustment of what science produced. They had numerous examples of the highest scientific advance in a country being utilised for low purpose and not the right purposes. What he suggested, said Pandit Nehru, was that while they must necessarily specialise, they must look at their problem in its wider perspective as part of the human problem, as a part in the historical perspective as well as in the human perspective and then perhaps they might see it in its right place. Thus when they made their new discoveries, they might also think of the factors of balancing their discoveries. There should be an attempt to preserve everything that they had gained today and to add to it. There should be a further attempt to balance their gains in various ways, in the social and economic spheres and in the realm of spirit.

I would like you scientists to think about this aspect of the problem, because it affects all of us very greatly and all our achievements may be swept away by the great world disasters and catastrophes, simply because we work in our grooves and others work in their grooves and great forces work in contrary directions and are not balanced. The Governor appealed to you, men of science, not to help forces of evil and destruction. That applies to each one of us, wherever we may be and we should endeavour not to ally ourselves in any way with the forces of evil and destruction. It is no good getting excited against this nation or that as most people do. Most people and most nations are alike more or less. They have their good and bad points. In a way, the problem has to be looked at impersonally, objectively and scientifically to understand the various forces that are at work today in the world, know men's minds, understand them and try to help the right forces and the right urges."

Pandit Nehru, referring to the development of communications, said that air travel took them quickly from one part of the world to another and there were no political frontiers in the air. It was the mind of man that had achieved everything and developed everything. The mind of man was still probing into the mysteries of nature and the universe and probing with success. Most of the people in most parts of the world had not quite adapted themselves to the great achievements of science which they used daily. They used them just as so many people used the aeroplane in India, but they were as far removed to everything which an aeroplane signified or meant as anything could possibly be.

Pandit Nehru said that today there was very little poise left in the nations and even statesmen went about openly cursing each other in conferences and in other places with the result that they lived in an atmosphere of extreme tension with possibilities of wars or domestic conflict. Surely there was something very wrong about the world where all these conflicts and tensions took place and if they did not understand what was wrong and help to the extent they could in setting it right, they were living in an artificial atmosphere. It should be the job of science or particularly some departments of science to try to solve these problems by developing to some extent a philosopher's bias in addition to the scientist's outlook. They required in every field of life, especially for men at the top, a touch of philosophy, not too much of metaphysics which was most dangerous, but understanding problems of human life and applying science to the solution of those problems. (Cheers.) This was not merely a question for the politician or the scientist, it was a question for every sensitive thinking human being. Obviously, scientists were both sensitive and thinking and therefore, it was a question for them. They put up a vast number of laboratories and produced results which helped them to meet this problem or that problem.

and then some overwhelming catastrophe came which put an end to their laboratories and to their work. It was an astounding position and he could hazard a few guesses as to the reason for it. A high degree of specialization had produced highly talented persons and even a man of genius but often enough a person who was a very bad citizen in the real sense of the word. Each person worked in his special groove, but there was very little of co-ordination between different grooves and all his work was upset from time to time by great forces of which he had no understanding, because he did not even try to understand them as they fell outside his groove. Pt. Nehru urged that they had to understand these great forces, control them or divert them along right channels. If there was a conflict today in the world between forces of destruction and forces of construction, they must try to encourage and support and help in every way the latter.

9 ANNUAL REPORT OF THE EXECUTIVE COMMITTEE OF THE INDIAN SCIENCE CONGRESS ASSOCIATION, 1948.

INTRODUCTION

The year under report has been one of increasing activity and recognition for the Indian Science Congress Association. Several Members and office bearers of the Association were invited by the Government of India to work on a number of Expert Committees and Commissions to give advice to Government in their post-war development schemes and also for delegation in foreign countries. Unlike last year, there were no disturbances in the city of Calcutta and this enabled the office to complete a large amount of the arrear work (printing of proceedings, etc.) that accumulated because of the disturbed situation and the consequent breakdown of printing facilities in 1947. As in the previous years, the I.S.C.A. received recognition from many foreign scientific associations, and enquiries from a large number of scientific bodies in Australia, America, Canada, Great Britain, Russia, etc. Several invitations were received from countries such as Ceylon, Afganistan and Indo-China and messages of good will were also sent. Unfortunately, due to lack of funds and inability of the Association to send out delegates to the various conferences, etc., reciprocity could not be adequately maintained. However, messages of goodwill and telegrams were exchanged with these bodies, so that contact could be maintained and development of mutual relations could be extended in future, if such possibilities arise later. It is a welcome sign that the I.S.C.A. is not only making its existence felt in scientific fields but its work is being increasingly recognised outside the geographical borders of India.

Thirty fifth Session :—The 35th session of the I.S.C. was held at Patna from 2nd to 8th January, 1948 under the auspices of the University of Patna and was presided over by Sir Chandrasekhara Venkata Raman. Sir Ram Nath Chopra, the President-Elect, was prevented from attending the session as a result of a surgical operation which he had to undergo just before the Session. Sir C. V. Raman being the seniormost past President was requested to preside over the function and he very kindly agreed to do so. All the 13 Sections of the Congress had their separate sessions and the attendance of Ordinary and Session Members was very satisfactory. In fact, a great deal of enthusiasm was seen on this occasion, partly because of the presence of foreign scientists from Great Britain, Norway, Mexico and Australia and partly also for the fact that the general public of Patna attended the session in large numbers. The General Committee met once during the session under the chairmanship of Dr. S. L Hora and later of Sir C. V. Raman and discussed several matters of importance regarding the general policy, administration and the lines on which the future policy of the Association should be canalised for the benefit of the country at large. A detailed separate leaflet has been circulated to the Ordinary Members and is also being distributed from the Office of the General Secretary in the Congress enclouses.

EXECUTIVE COMMITTEE

The Executive Committee (consisting of 17 Members) which is entrusted with the transaction of all current business of the Association met 7 times since the last Patna session. Most of the meetings of the Committee were held at Calcutta.

Of the Members of the Executive Committee, Dr. A. C. Ukil and Sir K. S. Krishnan were out of India on tour during different periods of the year, 1948. Dr. J. N. Mukherjee has been elected to the Governing Body of the Indian Research Fund Association as a representative from the I. S. C. A. in the vacancy caused by the termination of the period of office of Dr. B. C. Guha. Dr. Mukherjee will be on the Governing body of the I. R. F. A. for a period of three years from December, 1948.

The British Association for the Advancement of Science extended an invitation to the I. S. C.A. to send representatives at their annual meeting to be held on 15th September, 1948. The Executive Committee recommended the names of Prof. Lewis L-Fermor, Lt. Col. C. L. Pasricha and Dr. D. Chatterjee. With the consent of the Executive Committee, an informal discussion was held with the Department of Scientific Research and an invitation was extended to the International Geological Congress to hold its next session in India in 1951. The National Institute of Sciences of India, it was understood, would also be sponsoring this project. No expenditure would however be involved on the part of the I. S. C. A. in this connection. On an invitation from the sponsores of the 8th Biological-Chemistry Congress to be held in Paris from 6th to 8th October, 1948, the Committee nominated Dr. S. N. Das Gupta and Dr. R. Naidu of the U.N.E.S.C.O. and Dr. S. C. Neogy, who were in London at that time to represent the I.S.C.A. at this meeting.

Messages of good will and telegrams expressing the felicitations of the I.S.C.A. were sent to the South Indian Science Association on their Silver Jubilee Celebrations on 25th March, 1948, to the Centenary Celebrations of the Thomasson College of Engineering, Roorkee, to the Benares Hindu University on the occasion of the Silver Jubilee Celebrations of the College of Technology. The Ceylon Association of Science sent an invitation to the I.S.C.A. to send representatives to their annual meeting to be held in the first week of December in Colombo. The Executive Committee nominated Dr. B. Sanjiva Rao, Dr. B. B. Dey and Dr. B. Mukerji as the representatives of the Association to attend the meeting.

GENERAL ADMINISTRATION

Prof. P. C. Mahalanobis, the General Secretary, who was again invited by the U.N.O. to go out of India, felt that it would not be fair on his part to continue as General Secretary and therefore tendered his resignation on the 5th of January, 1948. At the last General Committee meeting held in January, 1948 at Patna on the same day, Dr. B. Mukerji, Acting General Secretary, was unanimously elected to take his place. Prof. M. Qureshi, the Senior General Secretary, because of his transfer from Hyderabad, could not keep contact with the activities of the Association and therefore the Executive Committee decided to appoint Dr. B. Sanjiva Rao of the Indian Institute of Science, Bangalore, in his place. This appointment will have to be ratified at the General Committee meeting to be held at Allahabad in January, 1949.

Government of India Grant-in-Aid: Since its inception in 1914, the I.S.C.A. had been carrying on its activities partly with the help, in the earlier years, of the Royal Asiatic Society of Bengal and largely depended on its own membership subscriptions, as no adequate State aid was available at that time. With the steadily expanding activity of the Association and a consequent increase in the expenditure side, and in view of the fact that an increase in the membership subscription might result in discouraging the younger scientists from joining the Association, the Executive Committee decided to approach the Government of India for a lump sum grant of Rs. 25,000 for the year 1948-49. In the years 1945-46 and 1946-47, the Government sanctioned a sum of Rs. 5,000 for the I.S.C.A. During the year 1947-48, the Association made a strong case for an increase in the annual grant and in response to this, Government granted a sum of Rs. 15,000 for the year 1947-48. It is expected that the same amount would be sanctioned for the year 1948-49 but unfortunately no definite information has yet been received from the Government though several reminders have been sent. If this grant is not received, it will be very difficult for the Association to maintain the office and the regular staff and to carry on with its usual publication activities. The cost of paper, printing and the overhead charges in connection with dearness and other allowances have increased to such an extent that the income of the Association from the membership fees is considered inadequate to meet all these demands. The Executive Committee therefore decided to recommend an increase in membership fees from Rs. 12 to Rs. 15. This recommendation will have to be considered by the Council and then by the General Committee Meeting for final ratification.

Permanent housing of the Association and appointment of staff: It will be recalled that the office of the Association was moved to the buildings of the Royal Asiatic Society of Bengal at No. 1, Park Street, Calcutta in 1947, when the present Secretary was acting in place of Prof. Mahalanobis. Until that time, the headquarters of the Association were in the University College of Science at No. 92, Upper Circular Road and later in the Statistical Laboratory, Presidency College, Calcutta. With the acquisition of space in the Royal Asiatic Society of Bengal Building, the Association started its own independent office and at present all the sections of the office are located there. Unfortunately, the space available for use of the Association is not the enough and the General Secretary has to bring most of the files, etc., to his own office for disposal. This is unsatisfactory and causes delay in the receipt and despatch of urgent and important communications. Efforts are being made to secure some more space in the buildings of the R.A.S.B. through informal discussions with the officers of the Society. But there seems little possibility of success, as the Society itself is expanding its activities and increasing its libraries and reading rooms. It is a pity that an Association as old as the I.S.C.A. is still without any building of its own. The Executive Committee gave anxious thought to this problem and tried to explore opportunities for securing some space where a building could be erected through public donations, if necessary. If the Association could be housed in a building of its own, there is every possibility that a new scientific centre would be developed to serve independent scientific and educational organisations. The American Association for the Advancement of Science was housed in the Smithsonian Institute until 1946 and the British Association in the Burlington House, London. Attempts are also being made to secure a suitable location for the Association in one of the University or public buildings under the Government of West Bengal but the chances in this connection are not bright.

Mr. B. L. Mukherjee, who was appointed Assistant Secretary to the Association through advertisement left his appointment on the expiry of his term of probationary period on 30th June 1948. To avoid unnecessary delay in the appointment of a successor and in view of the accumulation of arrear work for the two sessions (Delhi 1947 and Patna 1948), the Executive Committee decided to recruit a candidate from local applicants in Calcutta in an officiating capacity for 6 months in the first instance. Accordingly a Selection Committee was formed with Dr. W. D. West, Prof. G. P. Majumdar and the General Secretary and five candidates were called for interview. The Committee considered Mr. P. C. Bandopadhyay, the Assistant Secretary of the Indian Chemical Society and who had nearly 10 years' association with the I.S.C.A., as the best candidate and offered him the appointment. Mr. Bandopadhyay, however, could not join the appointment as during the interim period he secured another appointment in the office of the U.N.E.S.C.O. at Delhi. The post has since been advertised and recruitment will be made towards the end of January, 1949. The General Secretary was therefore forced to carry on the work single-handed during the period from June to end of this session. This meant a great the strain, particularly in view of the large accumulation of arrear work.

Another important requirement of the Science Congress Office is a permanent accountant. The funds at the disposal of the Association are not adequate to create a new post and therefore, with the permission of the Executive Committee, the Secretary took the help of a private auditor's firm to do the accounting work for this session. In the next session, if funds are available, efforts will be made for the appointment of an accountant.

Printing of the Proceedings : All the Proceedings of the Delhi Session 1947 and the Patna Session 1948 could not be issued in time, largely due to the disturbances through which Bengal passed during those two years. All this arrear work had to be made up and the Executive Committee is glad to be able to report that through the enthusiastic and determined effort of the General Secretary all the four volumes of the Delhi Proceedings & three volumes of the Patna Proceedings have been printed off and distributed to the Members entitled to receive these. Only part IV of the Patna Proceedings has not yet been issued. However, work in this connection has progressed well and it is hoped that after the forthcoming Allahabad Session is over, this could be issued. Shortage of paper was another serious difficulty which the Executive Committee had to face in 1948. The Association consumes nearly four tons of paper every year. During the last year, the paper quota was received only in November and this could not be properly utilised. At the request of the Executive Committee, the General Secretary proceeded to Delhi and succeeded in securing the necessary paper for the Association through the help of Hon'ble Dr. Shyamaprosad Mookerji and Sir J. C. Ghosh, to both of whom the Executive Committee would like to record their grateful thanks.

This year, abstracts of papers are being issued in advance from the Office of the General Secretary at the venue of the Congress at Allahabad. As many abstracts as were received in the office of the Association, duly checked and approved by the Sectional Presidents and the Correspondents up to the end of November, have been incorporated. It is unfortunate that most of the Members did not send their abstracts in time and with full papers. Unless the abstracts are received in time and with full papers, the Executive Committee have decided that in future no abstracts will be printed. The Rules of the Association already provide for this but in view of the abnormal circumstances that prevailed in 1946 and 1947, this Rule was relaxed to a certain extent. Apparently, many members are taking advantage of this, which, in the opinion of the Executive Committee, should be definitely stopped with effect from 1949. This discipline is necessary as otherwise many abstracts whose full papers are far from completion are presented and this indirectly lowers the prestige and scientific status of the Association.

WORK OF DIFFERENT SUB-COMMITTEES.

(i) *Sub-Committee on Standard Time for India:* This Sub-Committee completed its labours and submitted its report which was printed and circulated to various bodies, including the Director General of Civil Aviation of the Govt. of India. It is pleasing to note that both the Railways and the Airways authorities in India and the respective Government departments are now keen to adopt a uniform Standard Time all over India and have agreed with the recommendations of the Sub-Committee that there should be one Indian Standard Time (5½ hours ahead of the G.M.T.) for the whole of India.

(ii) *Sub-Committee on Award of Certificates to the Manufacturers of Scientific Instruments and Apparatus:* No further progress was made in the work of this Sub-Committee.

(iii) *Decimalization Sub-Committee:* A Sub-Committee was appointed with Mr. P. Sett of the Indian Decimal Society as Convener. This Sub-Committee has kept up an energetic propaganda through the medium of the daily press and has also published three pamphlets, outlining the advantages of the decimalization system were widely circulated. A small grant from the Funds of the Indian Science Congress Association was made to defray the expenses incurred by the Sub-Committee towards printing charges.

SHIFTING OF THE DATE OF THE SCIENCE CONGRESS SESSION

This question was again taken up in 1948. Prof. D. D. Kanga of the Theosophical Society of Madras suggested that the Science Congress Association should hold their annual session from 30th January to 12th February, which period he proposed to be adopted as the new annual holidays for India in future years in place of the Christmas Holidays of now as in vague. After some discussion, the Committee decided to postpone consideration of this issue to a later date, when ideas regarding national holidays will be more definitely finalised by the Central Government.

VISIT OF FOREIGN SCIENTISTS

It will be recalled that during the Patna Session, several foreign scientists, such as Sir Robert Robinson, Sir Edward Appleton, Dr. Severre Pettersen, Prof. Niels Bohr, Prof. A. Einstein, Dr. H. Mark, Dr. W. A. Shewhart, Dr. Vannevar Bush, Prof. Szent Gyorgyi, Prof. C. H. Best, Dr. G. Strode, Prof. J. H. Burn, Prof. C. A. Elvehjem, Prof. D. Engelhardt, Prof. J. Curie, were invited. But due to the delay in the receipt of intimation regarding the invitation only three foreign scientists—Prof. Petterssen, Dr. W. Shewhart and Dr. Vallarta—could actually honour the invitation of the I.S.C.A. The Committee, in considering the question of extending invitation to foreign scientists during the Allahabad Session in 1949 felt that in view of the fact that some of the invited scientists could not come to India during the last Patna Session, they should again be invited this year and accordingly the General Secretary was authorised to proceed to Delhi and discuss this question with Sir S. S. Bhatnagar, the Secretary of the Department of Scientific Research and come to a definite conclusion in this regard. After consultation with Sir Shanti Swaroop and also with Sir K. S. Krishnan, the President-Elect and with the members of the Executive Committee, it was decided that invitation should be extended to the following scientists for the Allahabad session of the Congress in 1949. It was further decided that invitation should go officially from the Government of India, Department of Scientific Research, and that the General Secretary should also write independently to the individual scientists, so that no further delay occured in conveying the invitation of the I.S.C.A. to the different scientists. The Government of India also agreed to see that the different scientists were contacted through the agency of the various Indian Ambassadors and Embassies in the foreign countries. In addition to the invited foreign scientists, it is expected that a few foreign scientists, who are coming to India under the auspices of other organisations, would also attend the Allahabad Session in 1949. The I.S.C.A. have extended a cordial invitation to these scientists also and have agreed to look after them regarding accommodation, stay, etc. during the period of the session at Allahabad.

1. Sir Robert Robinson, (Great Britain)
2. Sir Henry Tizzard, (Great Britain)
3. Prof. Herman Mark (America)
4. Prof. J. Curie (France)
5. Port. Szent-Gyorgyi, (Hungary, now residing in America)
6. Dr. G. Strode, (America)
7. Dr. C. H. Best, (Canada)
8. Prof. D. Engelhardt, (Russia)
9. Prof. S. Chapman, (Great Britain)

COUNCIL

In a free India, scientists must come forward and take upon themselves the responsibility of helping the State with their expert knowledge and technical guidance. The Council of the I.S.C.A. represents all the scientific talents of the country and it is proposed to convene a special meeting of the Council at Allahabad to consider again the ways and means of improving the activities of the Association and bring this institution to the level of such organisations as the American and British Association for the Advancement of Science and benefit the nation with its advice and guidance in national affairs. The membership of the Association, including all classes as members, at present is only about 2000. It is urgently necessary that this number is substantially increased in future years to enable the Association to become a truly representative body in India and to speak and act on behalf of the whole nation on all scientific matters. A proposal for increasing the membership fee from Rs. 12/- to Rs. 15/- was considered suitable in view of the increasing cost of paper, printing charges and other overhead charges in the maintenance of the staff of the Association. This proposal was not however looked with favour by many members. This is being brought again before the Commitee for reconsideration with facts and figures justifying the increase in membership fee. If this proposal is approved by the General Committee, the financial position of the Association would be little better and would enable it to a certain extent to function more efficiently than before and serve its constituents in a better fashion.

A proposal was mooted by some members of the Executive Committee that a 'Scientific Directory' be prepared in 1949 or 1950. This proposal was considered to be a sound one but in view of financial stringency, this matter would also have to be brought before the Council for consideration.

General Committee

The Executive Committee would again like to approach the members for suggestions in writing for improving the work and activities of the Association. The outgoing Executive Committee feels that more could have been accomplished if they had more resources at their disposal and if the office of the Association could have been organised on a better plane. They like to emphasise that more collaboration is required from all members and particularly from younger scientists and each member should take upon himself the responsibility of bringing at least three other members to the fold of the Association.

This Science Congress even now represents the whole of geographical India and it is a pleasure to record that members are still on its list from Pakistan and some of them take active interest in its activities. The Association requests the members to show more personal interest in the activities of the Association and help in the enlistment of more benefactors to the Association so that more active interest is shown to its activities by industrialists and other big organisations. Many persons become members at the last minute and a large shifting membership is created which does not do much good to the activities of the Association in the way of furthering its activities. By personal influence this situation can be easily remedied and funds could be made forthcoming from industrialists and commercial organisations for the benefit of science.

Changes in Rules: It was decided that the term of office of each General Secretary shall be for a period of three years following the confirmation of the appointment by the General Committee (Rules 23 and 25). They shall not be eligible for re-election to the office for a period of three years after the termination of their appointment (Rule 25).

Budget: The budget estimates for the year 1947-48 are given in pages- ......for the information of the members. It will be noticed that the expenditure of the Association has increased considerbly. This is not unnatural and unexpected from an all round increase in staff salaries, dearness allowance, paper price and cost of publication. The urgent need for an increase in the membership fee from Rs. 12 to Rs. 15 is justified when the steady increase in the expenditure is taken into account. In the interest of continuity of work of the Science Congress, the members are requested to give their serious consideration to the proposal of increase of subscription which is being placed before them by the Executive Committee.

B. Mukerji,
B. Sanjiva Rao,
General Secretaries.

10. MEETINGS OF COMMITTEES

GENERAL COMMITTEE : JANUARY 6th, 1949.

A meeting of the General Committee of the Indian Science Congress Association was held at the Vizianagram Hall, Muir College Buildings, Allahabad University, Allahabad, at 2-30 p.m. on Thursday, the 6th January, 1949. The General President, Sir K. S. Krishnan, was in the Chair.

The following members were present :—

Mr. N. Adhikari, Dr. S. P. Agharkar, Mr. Y. K. Agarwal, Mr. K. H. Alikhuni, Mr. F. J. Arnikar, Mr. G. V. Asolkar, Mr. Chandra Bal, Dr. D. V. Bal, Dr. B. Banerjee, Dr. K. Banerjee, Mr. P. Banerjee, Dr. S. K. Banerjee, Mr. T. Banerjee, Mr. S. N. Bapat, Dr. C. Barat, Dr. J. N. Basu, Dr. N. M. Basu, Dr. S. K. Basu, Dr. U. P. Basu, Dr. P. N. Bhaduri, Mr. W. O. Bhagwat, Dr L. J. Bhatt, Dr. K. Biswas, Dr. P. C. Biswas, Mr. A. K. Bose, Mr. A. N. Bose, Mrs. Chameli Bose, Mr. Nirmal Kumar Bose, Dr. P. K. Bose, Dr. S. K. Bose, Dr. S. R. Bose, Mr. N. P. Benawari, Mr. K. C. Chakko, Mr. M. C. Chakraborty, Mr. M. Chakraborty, Dr. D. K. Chakraborty, Dr. M. L. Chakraborty, Mr. S. Chakraborty, Dr. S. K. Chakraborty, Mrs. Bani Chatterjee, Dr. M. L. Chatterjee, Dr. N. C. Chatterjee, Mr. S. C. Chatterjee, Dr. S. K. Chatterjee, Dr. R. N. Chaudhury, Dr. B. S. Chauhan, Dr. G. W. Chiplonkar, Mr. B. B. Chowdhury, Dr. J. K. Chowdhury, Mr. J. Coats, Mr. B. K. Das, Mr. M. S. Das, Mr. J. Datt, Mr. S. Datta, Mr. N. Datta-Majumder, Dr. K. L. De, Dr. S. Deb, Dr. A. N. Dey, Mr. K. R. Dixit, Mr. K. K. Dole, Mr. R. Dubey, Mr. A. Dutta, Mr. R. K. Dutt-Roy, Mr. N. Ghatak, Mr. A. K. Ghosh, Mr. L. Ghosh, Mr. L. M. Ghosh, Mr. N. C. Ghosh, Mr. N. L. Ghosh, Mr. S. K. Ghosh, Dr. S. M. Ghosh, Dr. T. N. Ghosh, Mr. S. S. Guha-Sarkar, Mr. N. L. Gupta, Mr. B. P. Gyani, Dr. S. L. Haor, Mr. K. M. Joshi, Mr. S. Jones, Dr. B. K. Kar, Dr. D. D. Karve, Dr. S. R. Khastgir, Dr. R. S. Krishnan, Dr. C. Mahadevan, Dr. L. D. Mahajan, Mr. G. G. Majumder, Dr. G. P. Majumder, Dr. R. C. Majumder, Dr. D. R. Malhotra, Mr. S. B. L. Mathu, Dr. G. D. Mathur, Dr. P. N. Mathur, Dr. K. C. Mazumder, Dr. H. R. Mehra, Dr. R. N. Mehra, Dr. T. K. N. Menon, Dr. M. L. Misra, Dr. R. Misra, Dr. R. C Misra, Dr. U. S. Misra, Dr. H. K. Mitra, Dr. K. Mitra, Dr. M. A. Moghe, Dr. S. T. Moses, Dr. H. K. Mookerji, Mr. R. C. Mukerjee, Dr. S. Mukerjee, Mr. S. N. Mukerjee, Dr. B. Mukerji, Dr. Y. Nagappa, Dr. U. S. Nair, Mr. A. K. Nandi, Dr. P. Nandi, Dr. C. S. Pande, Dr. P. G. Pande, Mr. K. C. Pande, Dr. C. S. Patel, Mr. M. G. Patel, Miss. Ragini Phadke, Dr. Satya Prakash, Dr. B. N. Prasad, Dr. G. S. Puri, Dr. C. Racine, Dr. B. Sanjiva Rao, Mr. K. V. Krishnamurthy Rao, Mr. G. Ray, Prof. P. Ray, Mr. J. P. Ray Chowdhury, Mr. A. K. Roy, Dr. S. P. Roy Chowdhury, Mr. S. P. Roy Chowdhury, Dr. D. Sadhu, Dr. A. K. Saha, Mr. A. K. Saha, Dr. J. B. Sane, Dr. B. B. Sarkar, Mr. B. K. Sarkar, Mr. P. S. Sarma, Dr. N. S. N. Sastri, Mr. D. Sen, Mr. J. M. Sen, Mr. J. R. Sen, Mr. P. Sen, Dr. S. K. Sen, Mr. S. K. Sen, Dr. J. C. Sen Gupta, Dr. Sadasiv Sen Gupta, Mr. Suresh Sethna, Dr. P. D. Shukla, Mr. D. Singh, Mr. R. S. Singh, Mr. B. N. Srivastava, Mr. H. D. Srivastava, Dr. S. Swaroop, Mr. N. R. Tawde, Dr. A. C. Ukil, Mr. P. S. Varma, Mr. K. S. Viswanathan, Mr. C. S. Venkateswaran and others were present.

1. The minutes of the last meeting of the General Committee held on 5th January, 1948 were read and confirmed.

2. The annual report of the Executive Committee, Audited Statement of Accounts for the year ended 30th November, 1948 and the Budget

Estimates for the year 1948-49 (already circulated) were then taken up for consideration. Dr. B. Mukerji, General Secretary, formally placed the Annual Report, Audited Statement of Accounts and the Budget Estimates before the meeting. There was some discussion on the Budget Estimates in which several members participated. Dr. B. Mukerji explained that the Budget did not include the probable expenditure that would be involved in connection with the Foreign Scientists Delegation. Expenditure incurred in connection with the foreign delegation would be met from a separate fund (Govt. Grant) for which a separate account would be maintained. General opinion was in favour of strengthening the financial position of the Association. As no specific objection was raised on the item, it was adopted.

3. *Ways and Means of improving the work of the Association and question of increasing the rate of membership subscription from Rs. 12/- to 15/-:*: Dr. B. Mukerji (General Secretary) placed before the meeting the opinion of the Council with regard to the increasing of membership subscription. The Council was not in favour of increasing the subscription which was recommended by the General Committee and question of increasing the membership subscription was then postponed for the present.

4. *Announcement of elections to the Executive Committee and the Council*: Dr. B. Mukerji (General Secretary) reported the following results of the election of members to the Executive Committee and to the Council for the year 1949-50.

Executive Committee: 1. Dr. U. P. Basu, 2. Dr. A. K. De, 3. Dr. B. C. Guha, 4. Dr. D. S. Kothari, 5. Dr. B. G. Kundu, 6. Prof. B. Narayana, 7. Dr. Baini Prashad, 8. Prof. P. Ray, 9. Mr. B. K. Sarkar, 10. Dr. A. C. Ukil.

Council: 1. Dr. R. C. Bose, 2. Dr. D. Chakravarti, 3. Mr. A. M. N. Ghosh, 4. Prof. S. N. Mathur, 5. Mr. S. N. Mukherjee, 6. Dr. J. S. Patel, 7. Dr. B. N. Prasad.

5. *Announcement of the name of the General President for the 1950 Session:* Sir K. S. Krishnan (General President) announced that the Executive Committee had recommended the election of Prof. P. C. Mahalanobis, F.R.S. as General President for the 1950 Session. The proposal was confirmed amidst acclamation.

6. *Announcement of the names of Sectional Presidents and Recorders for 1950 Session:* Sir K.S.Krishnan (General President) announced the names of Sectional Presidents and Recorders for 1950, as follows:—

Section	President	Recorder
1. Mathematics ..	Dr. N. M. Basu	Dr. B.R. Seth
2. Statistics ..	Dr. P. V. Sukhatme	Mr. K. C. Basak
3. Physics ..	Dr. R. N. Ghosh	Mr. Vikram A. Sarabhai
4. Chemistry ..	Dr. J. K. Chowdhury	Dr. R. D. Desai
5. Geology & Geography ..	Mr. Joseph Coates	Mr. N. L. Sharma

	Section.	President.	Recorder.
6.	Botany ..	Dr. P. Maheswari	Prof. J. F. R. de Almeida
7.	Zoology & Entomology..	Dr. B. C. Basu	Dr. B. S. Chauhan
8.	Anthropology & Archaeology ..	Dr. Christoph Von Furer Haimendorf	Mr. Gautam Sankar Ray
9.	Medical & Veterinary Sciences ..	Dr. M. V. Radhakrishna Rao	Dr. C. R. Das Gupta.
10.	Agricultural Science ..	Mr. R. L. Sethi	Mr. L. C. Sikka
11.	Physiology ..	Dr. Kalidas Mitra	Dr. N. N. Das
12.	Psychology & Educational Science ..	Prof. Kali Prasad	Mr. L. J. Bhatt
13.	Engineering & Metallurgy ..	Dr. D. R. Malhotra	Mr. J. Dutt

7. *Venue of the next annual session*: The Chairman announced that invitation to hold the next session of the Congress had been received from the Poona University. It should be recalled that last year the Poona University had requested the Indian Science Congress Association to hold its present Session there but at the Patna session preference was given to Allahabad. It was therefore considered desirable that the invitation from the Poona University should be accepted and it was confirmed by acclamation.

8. *Election of two members to each of the 13 Sectional Committees*: The General Committee then proceeded to the elections of members to each of the 13 Sectional Committees. After the names were proposed and seconded the following elections were made by majority of votes :

Mathematics	Dr. C. Racine and Prof. M. L. Misra.
Statistics	Mrs. Chameli Bose and Mr. K. R. Nair.
Physics	Mr. N. K. Saha and Dr. S. R, Khastgir.
Chemistry	Dr. R. K. Dutt Roy and Dr. R. C. Shah
Geology and Geography ..	Dr. R. C. Misra and Mr. A. K. Ray.
Botany	Dr. P. N. Nandi and Dr. P. N. Bhaduri.
Zoology & Entomology ..	Dr. S.P. Roy Choudhury and Dr. S.M. Ghosh
Anthropology & Archaeology	Dr. Sushil Kumar Basu and Miss. Hilda Raj
Medical & Veterinary Science	Dr. R. N. Chaudhury and Dr. A. K. Bose
Agricultural Sciences ..	Mr. S. C. Ray & Mr. S. P. Ray Choudhury
Physiology	Dr. S. M. Banerjee & Dr. Sachchidananda Banerjee
Psychology & Educational Science	Mrs. Santa Deb & Mr. Samiran Banerjee
Engineering & Metallurgy	Mr. K. L. De & Dr. Himansu K. Mitra.

VOTE OF THANKS

Sir K. S. Krishnan (General President) proposed from the chair a Vote of Thanks to H. E. the Governor of U.P. for consenting to be the Patron of the Association for the Session at Allahabad and opening the Session (carried unanimously).

Dr. B. Mukerji (General Secretary) proposed a vote of thanks to the Vice-Chancellor of the Allahabad University for his kind invitation to hold the session under the auspices of the Allahabad University (carried unanimously).

Dr. B. Mukerji proposed a vote of thanks to the Chairman and the members of the Local Committee for the splendid arrangements made for the session (carried unanimously).

Dr. B. Sanjiva Rao (General Secretary) proposed a vote of thanks to the Local Secretaries for the all local arrangements and to volunteers for their help in organising such a big session (carried unanimously).

Dr. B. Mukerji proposed a vote of thanks to Prof. P. Ray, Treasurer, for his services during the past year (carried unanimously).

Dr. A. C. Ukil, Member of the Executive Committee, proposed a vote of thanks to Dr. B. Mukerji (General Secretary) for organising the office of the Association and for completing all the arrears in the publications of the Association without the help of the Assistant Secretary during the major part of the last year.

COUNCIL MEETING—Allahabad Session.

A meeting of the Council of the Indian Science Congress Association was held at the Vizianagram Hall, Muir College Buildings, Allahabad at 5. 15 p. m. on Tuesday, 4th January, 1949. As the President, Sir K. S. Krishnan, was busy elsewhere, Prof. S. N. Bose took the Chair.

Present:—Dr. S. P. Agharkar, Prof. Saligram Bhargava, Dr. R. S. Krishnan, Prof. C. Mahadevan, Dr. G. P. Mazumdar, Dr. J. N. Mukherjee, Dr. U. S. Nair, Prof. Shri Ranjan, Prof. P. Roy, Prof. J. M. Sen, Dr. M. B. Sarkar, Dr. B. Sanjiva Rao and Dr. B. Mukerji (General Secretaries)

Proceedings.

The minutes of the meeting held on 1st. and 3rd January, 1948 at the Science College Buildings, Patna (circulated) were confirmed.

General discussion on the ways and means of improving the work of the Association. The Chairman opened the discussion with a brief account of the progress of the Association during the last 35 years and later requested the members present to express their opinions individually. Dr. J. N. Mukherjee emphasised the need for strict observance of the Rules and Regulations of the Association particularly in the matter of accepting abstracts for publication. Unless the full paper accompanied the Abstracts, these should not be printed. Dr. Shri Ranjan opined that the membership subscription should not be increased for financial improvement. Other means of raising funds from endowments from Universities and private and industrial organizations should be judiciously explored. He also added that for improving the work of the Association at least two important Statutory Meetings of the Executive Committee should be arranged in different important centres of India and T. A. should be given to members. Dr. S. P. Agharkar suggested that in order to avoid heavy expense, foreign delegations should be curtailed. He further stated that in the selection of foreign delegates, Council Members should be asked for opinion first. Dr. M. B. Soparkar suggested that an appeal should be made to industrial firms for donations to the Reserve Fund of the Association. Dr. J. M. Sen and Dr. G. P. Mazumdar stressed that no abstracts should be published unless it comes with the full paper. Supporting these points, Dr. Sanjiva Rao stated that each member should be informed individually that no abstracts will be printed unless it comes with the paper. He also suggested that there must be some limitation in the maximum number of abstracts that any individual member might submit for inclusion in the proceedings. Prof. Saligram Bhargava stated that as the Indian Science Congress Association is a big body, it may be broken up in three or four parts and meetings may be organised in different centres of India.

After discussion from all angles, the Council found itself not in favour of increasing the membership subscription. It was decided that the observance of the Rules and Regulations be strictly enforced from the ensuing Session. The Council also endorsed the view that there should be at least two meetings of the Executive Committee—one at the Head Quarters (Calcutta) and another in a suitable centre according to convenience and travelling allowance should be paid to members for attending such meetings.

With a vote of thanks to the Chair the meeting terminated.

Executive Committee.

Eight meetings of the Executive Committee were held during the year 1948-49. The annual report published earlier gives the important items of business transacted excepting those done at the meetings held at Allahabad. Most of the business done at these meetings have been reported to the General Committee.

Sub-Committee on Science and its Social Relations.

A meeting of the Sub-Committee was held at Allahabad on Monday, the 3rd January, 1949 at 9 a.m.

Members Present—Prof. S. P. Agharkar (in the Chair), Dr. K. N. Bagchi, Mr. Nirmal Kumar Bose, Dr. H. K. Mitra, Dr. Kewal Motwani, Dr. B. Mukerji, Dr. B. B. Sarkar, Dr. M. B. Soparkar, Dr. A. C. Ukil, and Prof. J. M. Sen (Convener). Mr. M. N. Basu (Recorder of the Section of Anthropology and Archaeology) was present on invitation.

1. Minutes of the meeting of the Sub-Committee held on the 28th July, 1948 at Calcutta, which had been previously circulated were confirmed.

2. The Annual Report for 1948, which was circulated to the members present, was read by the Convener (Prof. J. M. Sen) and adopted.

3. With regard to the symposium on Application of Science in India for Social Welfare, it was decided that it should be held on the 5th January, 1949, at 2 p.m. at the Vizianagram Hall. The Convener reported that a pamphlet had been published and would be distributed at the Symposium meeting giving the following aspects on the Problem of Application of Science in India for Social Welfare :—

(1) Natural Resources of India in relation to Social Welfare (by Dr. D. N. Wadia) ; (2) Natural Resources in relation to Social Welfare (Dr. M. S. Krishnan) ; (3) Application of Science for Social Welfare (Dr. W. D. West) ; (4) Application of Science for Social Welfare in relation to certain fundamental questions (Dr. H. K. Mitra) ; (5) Medical and Health Sciences in relation to Social Welfare (Dr. A. C. Ukil) ; (6) Application of Physiological Principles in the improvement of the efficiency and working capacity of man (Dr. B. B. Sarkar) ; (7) Organisation of Scientific Education (Prof. A. C. Banerji). The Convener also reported that the following Scientists would speak at the Symposium on the topics mentioned against their names :—(1) Sir J. C. Ghosh (Industrial Organisation in relation to Social welfare) ; (2) Sir S. S. Bhatnagrr (Organisation of scientific activities in the country) ; (3) Dr. J. N. Mukherjee (Agriculture and Social Welfare.) The Convener further mentioned that Prof. M. N. Saha had also promised to contribute a paper on University Organisation in Relation to Science and Social Welfare.

The members present noted with satisfaction that a symposium on the above-mentioned subject could be organised in connection with the 36th Annual Meeting of the Indian Science Congress, and suggested that the synopsises of the papers received for the symposium should be published in Part IV of the Proceedings of the 36th Session of the Indian Science Congress.

4. In regard to the question raised in Paragraph 6 of the Annual Report of the Sub-Committee, namely, whether Prof. D. D. Kanga's article on fundamentals of New Indian Civilisation would be published along with the proceedings of the Symposium, it was decided that the article should not be incorporated in the report of the Symposium as it did not form part of the subject but that an effort should be made to get it published in a suitable form and in a suitable journal.

5. As regards the two main questions raised by the Committee on Science and its Social Relations instituted by the International Council of Scientific Unions, viz.

(i) In which measure do the methods of international scientific works contribute to the creation of an international spirit and to the maintenance of peace?

(ii) In which ways could scientific organisations and scientists intensify their activities for the maintenance of peace?

it was resolved that a Committee consisting of Dr. A. C. Ukil, Dr. Kewal Motwani and Prof. J. M. Sen (Convener) be formed to prepare a draft on the subject for circulation and discussion among members.

6. As regards training of teachers on Sociology, the following resolution proposed by Dr. Kewal Motwani and seconded by Dr. A. C. Ukil was adopted :— .

In view of the urgent necessity and importance of the study of Sociology in all courses of general, professional and technical training in Indian Universities, this meeting of the Sub-Committee on Science and its Social Relations of the Indian Science Congress resolves to recommend to the Executive Committee of the Indian Science Congress Association to request the Government of India, Ministry of Education, to establish an Institute of Sociology to train teachers for the Department of Sociology at the Universities of India, and thus implement the statement made by the Hon'ble Minister of Education, Government of India, in February, 1948.

Further, Dr. Kewal Motwani was requested to prepare in consultation with Dr. A. C. Ukil and Mr. Nirmal Kumar Bose, a memorandum on Sociology for submission to the Indian Universities Commission now touring in different States and provinces of India.

7. The subject for the next year's symposium to be held in January, 1950, was decided to be left to the Sub-Committee.

8. The Sub-Committee recommended the following members to constitute the Sub-Committee for the ensuing twelve months :—

(a) Four representatives of the Executive Committee, viz, the General President, the two General Secretaries and the Treasurer, ex-officio;

(b) Presidents of the 13 sections of the Indian Science Congress, ex-officio ; and

(c) The following members of the Indian Science Congress Association: Dr. S. P. Agharkar (Poona), Dr. K. N. Bagchi (Calcutta), Prof. H. J. Bhabha (Bombay), Dr. Gilbert J. Fowler (Bangalore), Dr B. C. Guha (Damodar Valley), Prof. D. D. Kanga (Madras), Prof. H. P. Maiti (Patna), Dr. Kewal Motwani (Pondichery), Dr. H. K.Mitra (Jamshedpur), Dr. C. G. Pandit (Delhi,) Prof. M. N. Saha (Calcutta), Prof. Benoy Kumar Sarkar (Calcutta), Rai Bahadur K. D. Sawhney (Bombay), Sir S. S. Sokhey (Bombay), Dr. A. C. Ukil (Calcutta), Dr. D. N. Wadia (Delhi) and Prof. J. M. Sen (Calcutta). It was further resolved that Prof. J. M. Sen be elected Convener of the Sub-Committee.

With a vote of thanks to the Chair, the meeting terminated.

Annual Report of the Sub-Committee on Science and its Social Relations for the year 1948.

1. The Annual Meeting of the Sub-Committee on Science and its Social Relations was last held at Patna on the 2nd January, 1948, and a Symposium on 'Food and World Population' was held on the 3rd January, 1948. The minutes of the meeting of the Sub-Committee have already been published in Part I of the Proceedings of the 35th Session of the Indian Science Congress, and a short account of the discussions which took place at the Symposium will be published in Part IV of the aforesaid Proceedings at an early date. The opening address on "Food and World Population" was delivered by Dr. B. C. Guha (now a member of the Damodar Valley Corporation) and Prof. Sankaran, Mr. K. C. Basak, (Director of Economic Research, Indian Central Jute Committee), Dr. Kalidas Mitra, (Deputy Director of Health Services, Central Government, Delhi) spoke on the different aspects of the problem.

2. During March to May 1948, the minutes of the meeting of the Sub-Committee held at Patna on the 2nd January, 1948, the Annual Report for 1947, and certain papers regarding the activities of the Sub-Committee were forwarded to the members of the Sub-Committee (re-constituted in January, 1948, with the undersigned as Convener) who were also requested to forward their suggestions for the next year's symposium.

3. The following subjects were suggested by the members as being suitable for the next year's symposium :—

(i) Science and Human conflicts by Dr. Kewal Motwani.

(ii) Must destruction be the fate of humanity in the Atomic Age by Dr. H. K. Mitra.

(iii) Science and Scientists in the Atomic Age by Prof. D. D. Kanga.

(iv & v) After Materialism—what ? and "Food versus Currency" by Dr. Gilbert Fowler.

(vi) Psychology in the Service of Man by Prof. J. M. Sen.

(vii\ The Language of Science in India by Dr. C. D. Bhalerao.

(viii) The Effect of Application of Modern Science on Indian Society by Prof. S. P. Agharkar.

(ix) Introduction of the old system of 'Katha-Kathak' for the spread of scientific ideas in villages by Dr. K. N. Bagchi.

(x) Trends in Social Legislation by the Section of Psychology and Educational Science.

4. A meeting of the Sub-Committee was held on the 28th July, 1948, to finally choose the subject and to select the participants for the symposium to be held at the Allahabad Session of the Science Congress in January, 1949. On the suggestion of the Chairman (Prof. M. N. Saha) it was decided to hold a symposium on "Application of Science in Free India for Social Welfare," and it was proposed that Sir C. V. Raman, Sir S. S. Bhatnagar, Sir J. C. Ghosh, Sir K. S. Krishnan, Prof. S. P. Agharkar, Dr. J. N. Mukherji, Dr. H. J. Bhabha, Dr. A. C. Ukil, Dr. D. N. Wadia, Dr. W. D. West, Dr. M. S. Krishnan, Dr. S. Krishna, Prof. M. S. Thacker, Prof. M. N. Saha. and such other members of the Sub-Committee as would be willing to participate should be invited to contribute to the Symposium which would be held on the 5th January, 1949. It was subsequently decided to distribute a pamphlate containing the abstracts or synopsises on the topics to be discussed under the general heading "Application of Science in India for Social Welfare."

5. In February, 1948, Dr. Kewal Motwani wrote to the General Secretary of the Indian Science Congress Association enquiring what happened to a report on the Status of Sociology in the Indian Universities which he had ascertained in compliance with a resolution passed by the Sub-Committee at its annual session held at Delhi in January, 1947. It seems that a summary of his report i.e. the replies received by him from the Universities had been included by Dr. A. C. Ukil (Convener) in Paragraph 6 of the Annual Report of the Sub-Committee for the year 1947, which was considered on the 2nd January, 1948, at Patna. Although it is not contemplated to take any further action in regard to this enquiry, it may be reported that Rural Sociology has been included in the syllabus for the Degree Course in Agriculture prepared during 1948 by the University of Calcutta. Educational Sociology has also been included by the same university in the Post-Graduate Degree Course in Education. If Dr. Kewal Motwani so desires, he may be allowed to proceed with the publication of his report at his own cost rewriting it completely to suit his own purpose.

6. Prof. D. D. Kanga submitted an article on "the Fundamentals of New Indian Civilisation" about which a reference was made in the last year's Report. The Sub-Committee will have to decide at the Annual Meeting to be held on the 2nd January, 1949, whether the article will appear as an Appendix to the proceedings of the Symposium to be held on the 5th January, 1949, or will be published as a separate pamphlet on the subject.

7. Dr. Gilbert Fowler of Bangalore made a reference to the Social Relations of Science in his presidential address at the Annual General Meeting of the Society of Biological Chemists, India. Further, in a letter dated the 23rd December, 1948, addressed to the Convener of the Sub-Committee on Science and its Social Relations, Dr. Gilbert Fowler says that he "has been" more and more convinced that the real trouble of the world comes from the endeavour to seek the solution of the social problem without a real understanding of the necessary conditions for its solution—in fact, to seek a correct answer to the sum without paying any attention to the multiplication table. The various interesting subjects which have been chosen for the symposium at Allahabad are doubt-

lessly valuable and necessary to be properly handled, but in themselves, they do not, as a rule, develop anything like the driving power that the world is aware of behind the forces of Communism. The basis of real social progress is still to be found in the *oneness of all religions* and in the identity of aims, e.g. between the Apostle Paul and Mahatma Gandhi. There can be no doubt that we are living in a very critical time and however valuable the many subjects available for discussion may be, unless there is that inner consciousness of Life, which in itself carries adequate power to face the threatenings which are evident in the world, our efforts appear to be merely of academic interest."

8. The solution of the problem is no doubt difficult but thinkers all over the world are trying to tackle it. An editorial in the journal of the Indian Chemical Society (Vol. xi, Nos. 1 & 2, 1948) under the heading 'Role of Scientists in the Control of Atomic Energy' urged that scientists and technicians, while enlisting themselves as members of an international federation, should take an oath, in the words of Dr. Weltfish, as follows :—

> "I pledge myself that I will use my knowledge for the good of humanity and against the destructive forces of the world and the ruthless intent of men, and that I will work together with my fellow scientists of whatever nation, creed or colour for these our common ends."

9. The Committee on Science and its Social Relations, instituted by the International Council of Scientific Unions, at its meeting held at the UNESCO House, Paris, on the 15th and 16th June, 1948, had drawn up certain principles of a Charter for Scientists which will be presented to the general symposium on Application of Science in India for Social Welfare to be held at Allahabad on the 5th January, 1949. The principles of the Charter for Scientists will also be published in the proceedings of the Symposium.

10. The C. S. S. R. (Viz. the Committee on Science and its Social Relations) has also undertaken an enquiry on the importance of Science and of scientific co-operation for peace. The afore-said Committee has invited the opinion of the Indian Science Congress Sub-Committee on Science and its Social Relations on the following two main questions:—

(i) In which measure do the methods of international scientific work contribute to the creation of an international spirit and to the maintenance of peace?

(ii) In which ways could scientific organisations and Scientists intensify their activities for the maintenance of peace?

11. The afore-said Committee has also raised the question of giving attention to man himself as the fundamental unit of Society and, therefore, has asked everybody to consider three principal aspects of the social relations of science, viz—(i) The scientist before society, (ii) The changes introduced in human societies through the technological development of science. (iii) The antagonism between biological order and social order.

12. The Secretary of the National Institute of Sciences of India with his letter dated the 20th December, 1948, forwarded to the General

Secretary of the Indian Science Congress Association a copy of the full communication received by him from the C. S. S. R. of the International Council of Scientific Unions, and has requested that the views of the Indian Science Congress Association on the subjects mentioned in the above two paragraphs (10 & 11) might be communicated to the Institute at an early date. As the problems are of vital importance to all scientists in India they may be carefully studied by a few experts and examined by the Sub Committee, and then their views communicated to the Executive Committee of the Indian Science Congress Association for transmission to the proper quarters. The question of appointing a body of experts to examine the proposals should therefore be considered at the Annual General Meeting of the Sub Committee to be held on the 2nd January, 1949, and by the Executive Committee on the 5th January, 1949.

13. Dr. G. D. Bhalerao. D. Sc., Ph. D., Director, Indian Veterinary Research Institute, Izatnagar, who presided over the Section of Medical and Veterinary Sciences in January, 1948, and was a member of the Sub-Committee on Science and its Social Relations passed away suddenly on the 6th December, 1948. His place on the Sub-Committee has remained vacant.

14. As all correspondence connected with the work of the Sub-Committee was carried on by the office of the Indian Science Congress Association, the balance to the credit of the Sub-Committee which had stood at the same figures of Rs. 124-4-6, since December, 1916, was merged with the General Funds of the Indian Science Congress Association by the General Secretary after ascertaining the views of the Convener in October, 1948. It was felt that there was no point in keeping a separate account in this regard, as all expenses of the Sub-Committee were met by the general Office of the Association.

J. M. SEN;
Convener.

Resolutions of Sectional Committees.

Section of Geology and Geography.

Resolved that a Committee consisting of the following be appointed to draw up a scheme for the preparation of a National Atlas:

Prof. S.C.Bose
Prof. A.N.Kapur
Prof. A.S.Kalapesi
Dr. G.Kuriyan
Dr. S.P.Chatterjee
Dr. S.Muzaffar Ali
Dr. H.L.Chibber
Dr. R.N.Dubey
Dr. P.K.Ghosh and
Dr. S.C.Chatterjee with the last named as Convener.

The Committee will have power to co-opt experts from Botanical, Zoological, Forest and Meteorological Departments and the Indian Council of Agricultural Research. Resolved further that the scheme be forwarded to the Planning Department of the Government of India through the General Secretary of the Science Congress for execution by the appointment of experts. Resolved further that the Executive Committee of the Indian Science Congress be requested to provide facilities by way of travelling allowance and other incidental expenses to enable the Committee to complete the work as quickly as possible.

Resolved that the Executive Committee be requested to make necessary changes in the Rules of the Science Congress Association so that the election of two ordinary members to the Sectional Committees may be made by the members of the Section (suitably defined) concerned during the Session of the Science Congress.

* * *

II. RULES AND REGULATIONS

RULES

1. The name of the Association shall be the Indian Science Congress Association, and its objects shall be the advancement of Science in India by the annual holding of a Congress and the doing of all such things as are incidental or conducive to the above object, including—

(*a*) the holding and management of funds and property;

(*b*) the acquisition of rights and privileges necessary or convenient for the object of the Association;

(*c*) the management, development, improvement, disposal and sale of all and any parts of the property of the Association;

2. The Association shall consist of Ordinary Members, Sustaining Members, Benefactors, Honorary Members and Session Members.

3. Ordinary Members of the Association shall have the right to contribute papers for reading at the Session of the Congress, to receive free of charge all publications issued by the Association, and to fill any office in the Association on being duly elected thereto.

4. The annual subscription of Ordinary Members shall be Rs. 12. The subscription shall become due on the 1st February of each year and shall only be effective as payment for Ordinary Membership subscription, if received before the 15th July of the year.

5. Any Ordinary Member may compound for the payment of all future annual subscriptions by the payment of a single sum of Rs. 150.

6. Any Ordinary Member agreeing to pay one additional subscription (Rs. 12) during his period of membership shall be called a Sustaining Member.

7. Any person paying a lump sum of Rs. 500 or more or any institution paying a lump sum of Rs. 1,000 or more shall be a Benefactor of the Association, subject to the approval of the Executive Committee. Benefactors shall have all rights and privileges of Ordinary Members during their lifetime.

An institutional Benefactor shall have the right to nominate one person as Ordinary Member of the Association.

8. An Honorary Member shall have all the rights and privileges of Ordinary Members. Honorary Members, the number of whom shall be limited to fifteen at any one time, shall be persons eminent for their contributions to science or persons who have rendered conspicuous services to the cause of science in India.

Honorary Members shall be unanimously nominated by the Executive Committee subject to confirmation by the Council and the General Committee at its Annual Meeting. Not more than one Honorary Member shall be elected in any year.

9. There shall be three classes of Session Members:—

(*a*) Full Session Member—subscription Rs. 12 per session.

(*b*) Associate Session Members—subscription Rs. 5 per session.

(*c*) Student Session Members—subscription Rs. 2 per session.

10. Full Session Members shall have the right to contribute papers for reading at the Session of the Congress, and to receive, free of charge, all publications issued by the Association relating to the Session of the Congress of which they are Members.

Associate and Student Session Members shall have the right to submit papers for reading at the Session of the Congress of which they are Members provided such papers be communicated through an Ordinary or an Honorary Member of the Association.

A Student Member shall, before admission, be duly certified by the head of his or her institution to be a *bonafide* student.

Associate and Student Session Members shall receive, free of cost, the Abstracts of Papers contributed for the Session for which they are Members.

11. The official year of the Association shall commence from the 1st of February.

12. There shall be Officers of the Association consisting of the Members of the Executive Committee and Presidents and Recorders of Sections.

13. Only Ordinary and Honorary Members shall hold office in the Association.

14. The term of office of all officers of the Association except the President shall commence from the beginning of the official year and shall extend until the assumption of office by their successors, appointed in accordance with the provisions of these Rules. The President shall assume office on the opening day of the Annual Congress following the one at which he is appointed, and shall continue to hold office until the assumption of office by his successor.

15. There shall be an Executive Committee which shall carry on the Administrative work of the Association and submit such questions as it thinks desirable to a General Committee at its Annual Meeting during the Session of the Congress or at a Special Meeting of which due notice shall have been given.

16. The Executive Committee shall consist of the President-Elect for the following year, the two General Secretaries, the Treasurer and ten Members, Ordinary or Honorary, elected by the General Committee. For the purpose of this election, an Ordinary or an Honorary Member may propose the name of an Ordinary or Honorary Member for election to the Executive Committee. Such proposal must be seconded by another Ordinary or Honorary Member and must reach the General Secretary before the 15th September. The Executive Committee shall circulate the names, together with such other names, not exceeding three, as it may suggest, to all Ordinary and Honorary Members for election by ballot. The ballot papers will be scrutinised by the President or his nominee and the General Secretaries, and the results of the ballot will be announced at the meeting of the General Committee.

Ordinary or Honorary Members, who have been elected members of the Executive Committee for three successive years, shall not be eligible for election as members for a period of two years after the completion of their term of appointment.

The Executive Committee shall co-opt as member at least one and not more than two Local Secretaries for the ensuing Session of the Congress.

17. The Executive Committee shall have full power to transact all business in cases of emergency, notwithstanding any limitations hereinafter laid down, and to deal with all matters not otherwise provided for in these Rules including the making of such Regulations as may appear conducive to the good administration of the Association and the attainment of its objects; provided always that such Regulations be not inconsistent with anything contained in these Rules, that they be reported for the information of the next meeting of the General Committee, and that they be subject to rescission or alteration by the Executive Committee or by any meeting of the General Committee.

18. There shall be a General Committee which shall consist of all Ordinary and Honorary Members of the Association.

19. The General Committee shall meet at least once during each Session of the Congress, preferably, in the middle of the Session.

20 There shall be a Council which shall consist of all Members of the Executive Committee, and all such Ordinary and Honorary Members of the Association as have held office as President, General Secretary, Treasurer, or Managing Secretary of the Association, the Sectional Presidents for the ensuing Session, and in addition, seven Members of the Association, Ordinary or Honorary, elected by the General Committee. For the purpose of this election any Ordinary or Honorary Member may propose the name of an Ordinary or an Honorary Member for election to the Council. Such proposal must be seconded by another Ordinary or Honorary Member and must reach the General Secretary before the 15th September. The Executive Committee shall circulate these names, together with such other names, not exceeding three, as it may suggest, to all Ordinary and Honorary Members for election by ballot. The ballot papers will be scrutinised by the President or his nominee and the General Secretaries, and the results of the ballot will be announced at the meeting of the General Committee.

21. The function of the Council shall be to act as a body of advisers to be consulted by the Executive Committee on important questions of policy or scientific import.

22. There shall be a President who shall be nominated by the Executive Committee and whose nomination shall be submitted to the General Committee at its Annual Meeting during the Session of the Congress for confirmation.

23. There shall be two General Secretaries (one of whom shall be resident in Calcutta) who shall be nominated by the Executive Committee and whose nomination shall be submitted to the General Committee at its Annual Meeting during the Session of the Congress for confirmation.

24. There shall be a Treasurer who shall be nominated by the Executive Committee and whose nomination shall be submitted for confirmation to the General Committee at its Annual Meeting during the Session of the Congress.

25. The term of office of each General Secretary and of the Treasurer shall be for a period of three years following the confirmation of the appointment by the General Committee. They shall not be eligible for re-election to the office for a period of three years after the termination of their appointment.

26. In the event of a vacancy amongst the General Secretaries and the Treasurer, occurring between two Sessions of the Congress, the Executive Committee shall have the power to appoint a General Secretary or the Treasurer for the period up to the termination of the next Session of the Congress.

27. There shall be a Local Secretary or Local Secretaries for each Session of the Congress who shall be appointed by the Executive Committee.

28. There shall be a Local Committee for each Session of the Congress which shall be appointed by the Executive Committee.

29. The Local Secretary., or Secretaries, and the Local Committee shall jointly, on behalf of and in consultation with the Executive Committee, make all necessary arrangements for the holding of the Session of the Congress.

30 For the purpose of scientific deliberations during the Session of the Congress, there shall be such Sections corresponding to different branches of science as may from time to time be constituted by the General Committee on the recommendation of the Executive Committee. It shall be competent for any Section after the first day's meeting to hold its scientfic meetings in sub-sections for the purpose of dealing separately with different groups of papers submitted to that Section. A separate Chairman may be appointed by the Sectional President in consultation with the Sectional Committee to preside over each sub-section.

31. There shall be in each Section a President and a Recorder, who shall be appointed by the Sectional Committee in accordance with the procedure laid down in Regulation 1(8). Where this procedure has not been followed, these appointments shall be made by the Executive Committee. The appointments shall be placed for confirmation before the General Committee. In addition, there shall be Sectional Correspondent and a Local Sectional Secretary, who shall be appointed by the Executive Committee.

32. In each Section, there shall be Sectional Officers, namely, a President, a Recorder, a Sectional Correspondent, and a Local Sectional Secretary. The President and the Recorder shall be the chief executive officers of the Section. They shall have power to act on behalf of the Sectional Committee in any matter of urgency which cannot be brought before the Sectional Committee for consideration, and they shall report such action to the Sectional Committee at its next meeting.

The work of each Section shall be conducted by a Sectional Committee which shall be constituted as follows :—

(*a*) Sectional Officers.

(*b*) All Ordinary and Honorary Members of the Association who have been Presidents or Recorders of the Section.

(*c*) Two Members of the Association, Ordinary or Honorary, elected by the General Committee at its Annual Meeting during the Session of the Congress.

The Sectional President shall preside over all meetings of the Section and of the Sectional Committee. He shall be the Convener of the meetings of the Sectional Committee. His ruling shall be final on all points of order that may arise.

The Sectional Recorder shall act as the Secretary of the Sectional Committee, and shall maintain a proper record of the proceedings of the Sectional Committee and of the Section in a book provided for the purpose. He shall be responsible for the punctual transmission to the General Secretary of the recommendations adopted by the Sectional Committee, and of resolutions adopted by the Section.

The Sectional Correspondent shall be resident at the Head Quarters of the Association and shall be responsible for preparing for the press the material relating to his Section, according to the instructions of the Sectional President.

The Local Sectional Secretary shall be resident in the locality where the Annual Session is held, and shall be responsible for all local arrangements for the work of his Section, and for arranging the Sectional excursions in consultation with the Local Secretaries.

33. The Sectional Committee shall meet on the opening day of each Session of the Congress, and daily thereafter during the Session before the meeting of the Session unless otherwise determined at a meeting of the Sectional Committee.

In the absence of the Sectional President from any of its meetings the most senior member of the Sectional Committee present shall take the chair.

In their meeting on the opening day they shall

(*a*) elect a Sectional President and a Sectional Recorder for the ensuing year in accordance with the procedure laid down in Reg. 1 (8);

(*b*) determine the detailed arrangements for the Sectional meetings;

(*c*) select the papers to be read and discussed;
and in their meetings during the Session they shall also

(*d*) nominate a Sectional Correspondent and a Local Sectional Secretary for the ensuing year for the consideration of the Executive Committee;

(*e*) determine the contents of the Sectional Records in the Proceedings in accordance with Rule 34 (*e*);

(*f*) consider means of improving the scientific work of the Section, and make suggestions to the Executive Committee whenever considered necessary;

(*g*) select topics for discussions at the next Session of the Congress and make necessary arrangements (*i*) through the President of the Section concerned for discussions within a Section, and (*ii*) through the Sectional President who has initiated the proposal for a discussion in which more than one Section will participate.

34(*a*) All papers submitted for reading at the next Session for the Congress shall be forwarded to the General Secretary so as to reach him not later than September 15th of the calender year preceding the Session of the Congress at which the papers are intended to be read, provided that this date may be changed by the Executive Committee for special reasons.

(*b*) Any paper submitted for reading at the section of the Congress shall be accompanied by an abstract in triplicate.

(*c*) All papers submitted for reading at a Session of the Congress shall be checked by the Sectional Correspondent concerned or by such person or persons appointed by the General Secretary. The paper together with a copy each of the abstracts shall then be sent to the Sectional President concerned for refereeing and acceptance. Decision with regard to acceptance or rejection of any paper shall be final and all reports confidential.

(*d*) No paper published elsewhere shall be accepted.

(*e*) Only abstracts of the paper received by the General Secretary before September 15th in accordance with Rule 34(*a*), (*b*) and (*c*) shall be printed in Part III of the Proceedings. In exceptional circumstances, abstracts of papers received after that date and read before the Section, if specially recommended by the Sectional Committee, may be printed in Part IV.

35. The Proceedings of the Indian Science Congress Association shall be published in one volume in four separate parts, as follows:—

Part I. To contain the list of officers, the Proceedings of the opening meeting (except the General President's Address) and all official matters.

Part II. To contain the Presidential Addresses to be distributed to those present at the meeting after the addresses have been delivered, and to absent Ordinary, Honorary and Full Session Members by post after the meeting.

Part III. To contain the abstracts of papers to be read before the Section which are received before September 15th in accordance with Rule 34(*a*). No abstracts shall be included in this volume from authors who have not enrolled themselves as Members of the Association. These be distributed in advance of the meeting to all Members of the Association.

Part IV. To contain the discussions, the abstracts accepted in accordance with Rule 34(*e*), the lists of members and the index.

36. The following procedure shall be observed for the making of any addition to or alteration in the Rules of the Association:—

(*i*) Proposals for additions to and alternations in the existing Rules may be placed at any time before the General Committee by the Executive Committee.

(*ii*) (*a*) Proposals for additions to and alternations in the existing Rules by any Ordinary or Honorary Member of the Association shall be sent to one of the General Secretaries so as to reach him two full months before the meeting of the General Committee in which they are to be moved.

(*b*) One of the General Secretaries shall circulate such proposals to all Ordinary and Honorary Members of the Association at least one full month before the meeting of the General Committee.

(*c*) Any amendments to the proposals shall be sent by any Ordinary or Honorary Member of the Association to one of the General Secretaries so as to reach him at least a fortnight before the meeting of the General Committee.

(*d*) The proposals together with any amendments shall be brought up before the meeting of the General Committee at the Annual Meeting during the Session of the Congress together with any remarks of the Executive Committee and declared carried if accepted by a two-thirds majority of the constituent Members present and voting at the meeting.

(*Adopted* the 5th January, 1931. *Revised* the 5th January, 1935, the 6th January, 1936, the 5th January, 1937, the 8th January, 1939, the 6th January, 1940, the 5th January, 1942, the 4th January, 1943, the 5th January, 1945 and the 5th January 1948).

REGULATIONS

1. SECTIONAL OFFICERS.

(1) The President delivers a Presidential Address of which ordinarily the cost of printing 16 pages of the Proceedings in its usual form shall be borne by the Indian Science Congress Association and any author exceeding the limit shall bear the extra cost, provided that in no case the Presidential Address shall exceed 25 pages. The time available for delivery of the Presidential Address shall usually not exceed 25 minutes. The manuscript of the address, ready for the press, should be received by the General Secretary before October 15th of the calendar year preceding the Session of the Congress at which the address will be delivered, provided that this date may be changed by the Executive Committee for special reasons. It should be accompanied by 12 copies of a short popular summary (about 500 words) for issue to the lay press. The time and date of the Delivery of the President's Address will be communicated before the meeting of the Congress. No two Presidential Addresses will be delivered at the same time.

(2) The President shall be entitled to receive 30 copies of his address without charge, and additional copies at the cost of reproduction.

(3) Railway fares, postage, clerical or other expenses incurred by the Sectional Presidents will not be paid by the Association.

(4) The following procedure is adopted for the collection of papers for the Sections:—

About the middle of April a number of copies of a printed circular will be forwarded to the President of each Section who may arrange to send these to workers in that branch of science with which his Section is concerned, requesting them to contribute papers for reading before the next meeting of the Congress.

The circular will contain a clause inviting such workers as are not yet Ordinary Members of the Association to join as such. Particular note should be taken of the fact that no new Ordinary Members are enrolled after the 15th July of the year.

In the case of joint papers, each author must be a Member of some category.

(5) The President referees, either in person or by proxy, the papers received for reading before his Section in accordance with Rule 84.

Abstracts should be limited, except in very special cases, to about 200 words. Long abstracts should be reduced by the President. References to literature in abstracts should be avoided as far as possible and when given, should conform to the system of abbreviation used by the Association.

The contents of all abstracts should be carefully checked by the Sectional Correspondent concerned or by such person or persons as appointed by the General Secretary and the abstracts shall then be sent to the Sectional President for his final scrutiny and approval.

Joint discussions on related papers may be held. Authors of papers should be informed of the time allotted by the President to the reading of their papers. An author contributing more than one paper should be asked to specify which of them he would prefer to read at the meeting.

(6) The President, in consultation with the Local Sectional Secretary, shall make arrangements for such local sectional excursions as seem desirable. Due notice shall be given to the General Secretaries of all such arrangements.

(7) The President and the Recorder should, in consultation with other members of the Sectional Committee, make proposals to the General Secretary regarding the programme of the Section. Such proposals should reach the General Secretary not later than the 1st November, so as to enable the necessary details to be entered in the programme. General discussions on questions of importance, held either by a single Section or jointly by two or more Sections, should be encouraged.

The Sectional Presidents concerned shall communicate to the General Secretary before the end of July the titles of such discussions, the names of the speakers and such further information as may be considered necessary.

The Papers, together with three copies of abstracts, to be read by the contributors at a discussion shall be sent to the General Secretary on or before the 15th September of the preceding calendar year by the Sectional President concerned.

The materials relating to a discussion, in a form ready for the press, shall be communicated to the General Secretary within a month from the date on which the discussion takes place; the material not received by the General Secretary within this period shall not be published.

The President and the Recorder of the Section arranging a discussion shall carry out the necessary correspondence throughout the year during which they hold office.

(8) Early in November copies of a printed form will be issued to Presidents of Sections for circulation to members of the Sectional Com-

mittees requesting them to nominate a President and a Recorder for the ensuing meeting for consideration by the Sectional Committee. Such proposals shall be accompanied by a statement of qualifications of the nominees for the office and their willingness to accept the same if elected thereto.

During the first week of December, the President of each Section shall circulate all such proposals received by him, together with the statements of qualifications, to the members of the Sectional Committee and request them to nominate by ballot one member for each office from among the list circulated, the ballot papers being received by him up to the 20th December.

At the first meeting of the Sectional Committee held on the opening day, the ballot papers shall be opened and scrutinised as the Chairman shall direct and the result communicated to the Executive Committee for consideration, together with a complete record of the Proceedings in this connection.

(9) The duties of the Sectional Correspondent and of the Local Sectional Secretary are given in Rules 32 and 34 (c).

(10) All persons entitled to be members of the Sectional Committee should enrol themselves without delay as Ordinary Members if not already so enrolled and should inform the General Secretary of the payment of their subscription when accepting the appointment.

(11) The General Secretary should be consulted whenever any question arises not dealt with in these regulations.

II. LOCAL ARRANGEMENTS

In accordance with the Rules of the Association, the Local Secretaries and the Local Committee shall jointly, on behalf of and in consultation with the Executive Committee, make all necessary arrangements for holding the Session of the Congress.

The following arrangements have to be made :—

A. Accommodation for the Scientific Meetings

(1) A large hall should be available for (*a*) the President's address on the opening day, and (*b*) for the evening lectures. Both (*a*) and (*b*) are open to the public free of charge. A projection lantern with an operator should be available in this room, and it is a great advantage if loud speakers can be installed.

(2) Rooms for the meetings of the different Sections of the Congress should be provided and suitably furnished. An epidiascope with an operator should be provided in each sectional room. All the rooms should be as far as possible in close proximity. The following are the Sections of the Congress :

Mathematics, Statistics, Physics, Chemistry, Geology and Geography, Botany, Zoology and Entomology, Anthropology and Archaeology, Medical and Veterinary, Agricultural Sciences, Sciences, Physiology, Psychology and Educational Science, and Engineering and Metallurgy.

(3) A Reception room should be provided in which members can get information, write letters, etc. The Local Secretaries' Office should be as near as possible to this room. An arrangement should be made with the Postmaster-General to have a temporary Post Office in this room for all

letters addressed to members c/o The Indian Science Congress to be delivered here. The Indian Science Congress Post Office should be situated as near as possible to the Reception room.

(4) A room near the Reception room should be set apart for the General Secretaries' Office, which will be opened therein from the 31st December.

(5) Provision should be made for lunch in European and Indian styles at moderate charges near the Reception room.

B. Accommodation for Visiting Members

The Local Secretaries should send out, not later than the end of November, a printed circular to all members enrolled, asking them if they desire that accommodation should be arranged for them. It is desirable, as far as possible, to provide private hospitality for the President, Sectional Presidents and Officers of the Congress. In this circular information should be given regarding the types of accommodation available, with the charges, and the nature of the climate during the Session. The Local Secretaries will receive periodically from the General Secretary a list of members enrolled at headquarters.

C. Programme of the Meeting

(1) (a) The Sections of the Congress meet daily in the morning generally from 9-30 a.m.

(*b*) Presidential Addresses of the Sections shall commence from 9-30 a.m.

(*c*). There should be no afternoon Presidential Addresses of the Sections.

(*d*) Symposia or joint discussions will be held either in the morning or from 2 p.m.

(2) Public lectures are arranged by the Executive Committee, and are given at 6 p.m. or 6-30 p.m.

(3) A printed guide with a map of the locality in which the Congress is held should be prepared for distribution to members on the opening day. Only Ordinary, Honorary and Full Session Members are entitled to the Guide Book free of cost. A small charge not exceeding Re. 1 (to be fixed by the Local Committee) may be made to other members desiring to have a copy. The Guide Book should contain a summary of information concerning the scientific and educational activities and a short history of the locality, in addition to general information likely to be of use to visitors.

(4) Arrangements should be made for giving due publicity to the activities of the Congress, both before and during the meeting.

(5) A list of members with their local addresses, where known, should be printed and distributed on the opening day. A supplementary list should be typed and posted in the Reception room and maintained up-to-date. The Local Secretaries shall arrange for this.

(6) A provisional programme of social engagements should be drawn up by the Local Secretaries and sent to the General Secretary by the 25th November. It is essential that this be sent in time, as it has to be printed and distributed with the abstracts by the first week of December.

The General Secretary will make arrangements for printing the programme drafted as above and distributing those to members enrolled at the time of the distribution of the abstracts.

The final programme shall be printed locally by Local Committee in time for the opening of the Session.

D. General

(1) Numbered badges for members of the Congress will be sent by the General Secretary to the Local Secretaries for distribution on the opening day of the meeting. The badges should bear numbers corresponding to the enrolment numbers. There should be additional badges for Officers.

(2) Members of the Local Reception Committee who have made substantial contributions to the funds of the Local Committee may be given complimentary tickets to attend the meetings.

(3) An audited copy of the accounts of the Local Committee should be sent to the General Secretary not later than the 30th April, following the Session, for inclusion in Proceedings of the Session. It is desirable that the Local Committee should contribute any surplus to the Reserve Fund of the Association.

(4) Twelve copies each of all local publications connected with the Congress (Guide Book, final programme, notices, cards, etc.) should be sent to the office of the Association for record at the conclusion of the meeting.

(5) Applications for membership will ordinarily be dealt with by the General Secretary at the Office of the Association up to the 15th December. After that date applications for membership will be forwarded to the Local Secretaries, who will open a separate account for the sale of membership tickets. The amount thus realized, together with the unsold tickets, should be forwarded to the General Secretary immediately after the close of the Congress.

III. FINANCIAL

(1) The accounts of the Association shall be audited once a year and the books closed on the 30th November each year for this purpose.

(2) The audited accounts shall be placed before the General Committee at the Annual Meeting with the observations, if any, of the Executive Committee.

(3) Sanction for all payments for amounts exceeding Rs. 100 shall be obtained from the Finance Committee which shall consist of the General Secretaries, the Treasurer and one Ordinary or Honorary Member resident in Calcutta who shall be nominated by the Executive Committee.

(4) Amounts received on account of Life Membership Subscription shall be credited to the Reserve Fund of the Association.

IV. ELECTION OF REPRESENTATIVES OF ASSOCIATION BY THE EXECUTIVE COMMITTEE

(1) A letter shall be issued asking for nominations giving a last date therefor.

(2) The proposer should ascertain whether the person he proposes is desirous of serving in that particular capacity.

(3) After the nominations have been received the names should be circulated in a ballot paper and the date for return should be fixed two weeks after the ballot paper is sent out.

V. NOMINATION OF GENERAL PRESIDENT

(1) The General Secretary shall invite nominations for the office of General President of the Association, two years in advance, by a circular letter to the members of the Council, not later than the 15th of October. Such circular shall include a list of the General Presidents of the past 15 years, and the branches of science in which they had specialized.

Nominations shall reach the General Secretary not later than the 15th of November.

(2) The General Secretary shall circulate the nominations received to the members of the Executive Committee for expression of opinion on or before the 30th November. Such opinions shall reach the General Secretary not later than the 15th of December.

(3) The nominations, together with the views of members thereon, shall be placed for decision before a meeting of the Executive Committee to be held on the day previous to the commencement of the Session of the Congress.

(*Adopted* the 5th January, 1937. *Revised* the 8th January, 1939, the 6th January, 1940, the 6th January, 1941, the 5th January, 1942, the 4th January, 1943 and the 5th January, 1945).

STATEMENT OF ACCOUNTS

THE INDIAN SCIENCE

Statement

as on 1st.

	Rs.	As.	P.
Reserve Fund	20,062	0	0
Advance Govan Bros.	280	0	0
Balance General fund	8,655	7	0
	28,997	7	0

CONGRESS ASSOCIATION

of affairs

December 1947.

				Rs.	As.	P.
Furniture and Fittings				1,379	7	9
Reserve fund Investment						
G. P. Notes	12,977	9	10	20,062	0	4
Imperial Bank	7,084	6	6			
Advance Payments						
on Foreign Scientist 34th Session				3,005	4	0
Imperial Bank of India				4,333	3	11
Cash in hand				217	7	6
				28,997	7	6

THE INDIAN SCIENCE

1, PARK STREET,

BALANCE

as at 30th

	Rs.	As.	P.	Rs.	As.	P.
General Fund						
As at 1st December 1947 ..	8,655	7	0			
Add. Govt. grant for 1945-46 and 1946-47 received in this year ..	10,000	0	0			
	18,655	7	0			
Less excess of expenditure over income for the current year including deficit on Foreign scientists head at 34th Session	9,921	10	3	8,733	12	11
Reserve Fund						
As per last a/c	20,062	0	4			
Add. interest earned during the year ..	258	15	0	20,320	15	4
Liabilities						
Maidens Hotel	3,599	4	0			
Govan Bros	14,550	4	0			
Indian National Air Ways	3,973	6	0			
Indian Statistical Inst.	6,473	4	6			
Great Eastern Hotel	34	0	0			
Printing Audit fee and Rent	4,151	5	3	32,798	7	9
Suspense a/c						
Dr. M. S. Vallatra				1,149	0	0
				62,935	4	0

I have audited the above Balance Sheet as at 30th November 1848 and the
Scientists at 34th and 35 Session of the Indian Science Congress Association for the
have obtained all the information and explanations I required. Subject to my separate
Expenditure account are properly drawn up and the Balance Sheet exhibits the true
information and explanations given to me and as shown by the books.

10, Old Post Office Street,
Calcutta
10th December, 1948.

CONGRESS ASSOCIATION

CALCUTTA.

SHEET

November 1948,

	Rs.	As.	P.	Rs.	As.	P.
Furniture and Fittings						
As at 1st December 1947	1,379	7	9			
Additions during the year	1,283	12	3			
	2,663	4	0			
Less Dep. at 5% on 1379-7-9	68	12	0	2,594	3	0
Typewriter a/o				650	0	0
Outstanding a/c						
Govt. of India						
Foreign Scientist Grant for 34th Session ..	10,000	2	0			
,, ,, ,, ,, 35th ,, ..	18,537	3	3			
Burmah Shell	636	0	0	29,223	5	3
Advance (adjustable)				450	0	0
Reserve fund Investment						
4% Loan 1960/70 (Face value 5,000/-)						
3% 2nd Victory Loan 1959/61 (Face value 2,000/-)						
12 yrs. National Savings Certificate (5,000/-)						
at cost	1,9977	9	10			
Imperial Bank of India Reserve fund a/c ..	6,343	5	6	20,320	15	4
Charges Recoverable						
Excess Air Passage at 35th Session ..				5,619	4	0
Cash in hand and at Bank						
Cash in hand	99	0	0			
Imperial Bank of India	4.028	3	5	4,127	3	5
				62,985	4	0

Annexed Income and Expenditure account also the Statement of expenditure on Foreign
year ending 30th November 1948 with the books and vouchers of the Association and
report of even date I am of opinion that the Balance sheet and the Income and
and correct view of the Associations affairs as on that date according to the best of my

B. K. ROY.
Auditor.
Registered Accountant.

Statement of Govt. Grant and
at 34th Session

	Rs.	As.	P.	Rs.	As.	P.
To Railway Fares	2,941	15	9			
„ Hotel Charges	17,568	2	0			
„ Air Fares in India	19,204	0	0			
„ Allowance to Scientists	5,295	0	0			
„ Agency Charges of Govan Bros	355	8	0			
„ Telegram, Bedding and Sundry Charges ..	1,245	8	0			
„ Air Passages to and from India	35,886	16	0	82,595	10	9
				82,595	10	9

Statement of Govt. Grant and
at 35th Sesssion

	Rs.	As.	P.	Rs.	As.	P.
To Railway Fares	1,801	2	6			
„ Hotel Charges	862	0	0			
„ Allowance to Scientists	452	8	0			
„ Bedding and Sundry Charges	143	14	9			
„ Air Passages to and from India	16,827	10	0	18,587	3	3
				18,517	3	3

** In arriving at the total expenditure the two Air tickets from Karachi to New Washington and High Com., London and not availed by them, have not been realised the total deficit at 34th session over Govt. Grant will amount to

CONGRESS ASSOCIATION

Expenditure on Foreign Scientists at Delhi, 1947.

	Rs.	as.	p.	Rs.	As.	p.
By Govt. Grant for 34th Session				75,000	0	0
„ Balance being excess of expenditure over sanctioned Grant Transferred to General Income & Expenditure account				7,595	10	0
				82,595	10	0

Expenditure on Foreign Scientists at Patna, 1948.

	Rs.	As.	p.
By Govt. Grant (estimated)	18,587	3	3
	18,587	3	3

York for Prof. R. B. Thompson, and Prof. Oscar Riddle charged by Indian Embassy, taken into account as the amount is expected to be realised. If the same is not (Rs. 7,595-10-0 plus Rs. 5,619-4-0) Rs. 18,214-14-0.

To

The Members

Indian Science Congress Association.

1, Park Street, Calcutta.

Dear Sirs,

With reference to my separate report mentioned on the Balance Sheet I like to make the following observations :—

(1) Previous to this account as no income and expenditure accounts and Balance Sheets used to be drawn for financial years, information regarding Assets and Liabilities as on 1-12-47 could not be ascertained from the books. As such a statement of affairs as on 1-12-47 attached herewith was drawn from the informations as could be obtained from previous receipts and payments accounts and the same has been incorporated in the current period.

(2) Regarding general grant from Central Govt. of Rs. 26,300 received during the period Rs. 15,000 being for 1947-48 has been taken as current years income and credited to income and expenditure account and the balance being for the previous years has been separately shown as addition to general fund in the Balance Sheet.

(3) The total expenditure on Foreign Scientists both for 34th, 35th Sessions has been charged to this year's amount and the unpaid portion has been shown as liability in the Balance Sheet. The 34th Session shows a deficit of Rs. 7,955/10/- annas over the Govt. grant and has been charged to the Association's General Income and Expenditure Account. If this deficit be realised by a supplementary grant from the Govt. the actual deficit of the Association for the year will amount to Rs. 2,326/0/3.

(4) The sum of Rs. 5,619/4/- annas excess paid on account of Air fares to New York for Prof. R. B. Thompson & Oskerriddle at 34th Session being realisable has not been charged to this year's account but carried over in the Balance Sheet under the head "Charges Recoverable" If the same be not realised the deficit will be further increased by that amount.

Yours faithfully,

B. K. ROY.

THE INDIAN SCIENCE

1, PARK STREET,

Income & expenditure

for the year ending

	Rs.	As.	P.	Rs.	As.	P.
To Establishment	9,016	13	0			
,, Paper & Printing charges	30,198	5	3			
,, Postage and Telegram	1,982	6	9			
,, Rent & Taxes	900	0	0			
,, Contingent Expenses	438	2	3			
,, Stationery & Stores	112	0	0			
,, Travelling	415	14	0			
,, Telephone Charges	121	3	0			
,, Railway Freight	86	1	0			
,, Bank Charges	62	10	0			
,, Miscellaneous Expenses	26	9	0			
,, Audit fee for 1946-47	80	0	0			
,, Audit fee for 1947-48	100	0	0			
,, Depreciation on Furniture	68	12	0	43,608	12	3
,, Expenditure on Foreign Scientists at 34th Session (as per attached statement)				82,595	10	0
,, Expenditure on Foreign Scientists at 35th Session (as per attached statement)				18,587	8	2
				1,44,791	9	6

10, Old Post Office Street,
Calcutta.
10th December, 1948.

N. B.—Out of Govt. grants for 34th Session Rs. 10,000/- and the entire grant for

CONGRESS ASSOCIATION

CALCUTTA

account

30th November, 1948.

	Rs.	As.	P.	Rs.	As.	P.
By membership subscription	23,826	4	6			
,, Publication sales	1,154	7	6			
,, Govt. of India Grant for 1947-48	15,000	0	0			
,, Grant from National Institute of Science ..	1,300	0	0	41,282	12	0
,, Govt. of India Grant for Foreign Scientist 34th Session				75,000	0	0
,, Govt. of India Grant for Foreign Scientist 35th Session (Sanctioned) ..				18,587	3	3
,, Balance being excess of expenditure Over Income transferred to B/S				9,921	10	3
				1,44,791	9	6

Examined & Found Correct.
B. K. ROY,
Auditor.
Registered Accountant.

35th Session on account of foreign Scientists are still lying outstanding.

Estimated Budget for Revenue

EXPENDITURE

1. Revenue Expenditure

	Estimated for 1947-48	Actuals for 1947-48	Estimated for 1948-49
Establishment (staff salary including D.A. and proposed Provident Fund contribution from 1948-49).	12,000 0 0	9,016 13 0	13,350 0 0
Printing & Paper	32,000 0 0	30,198 5 3	31,000 0 0
Rent including proposed Library Room for 1948-49	3,500 0 0	900 0 0	2,100 0 0
Postage	2,000 0 0	1,982 6 9	2,000 0 0
Stationery & Stores	500 0 0	112 0 0	500 0 0
Telephone & Electric		121 3 0	300 0 0
Travelling (including to venue of the Session and conveyance)	800 0 0	415 14 0	1,500 0 0
Travelling Allowance to member of the Executive Committee and Council to attend meeting	5,000 0 0	Nil	5,000 0 0
Miscellaneous & Contingency including Railway Freight to the venue of the Session, Bank Cheque and Depreciation	650 0 0	682 0 0	1,000 0 0
Audit Fee	50 0 0	180 0 0	200 0 0
Excess expenditure on Foreign Scientists at 34th Session over sanctioned Government Grant	Nil	7,595 10 0	Nil
	56,500 0 0	51,204 6 3	55,950 0 0

2. Capital Expenditure

	Estimated for 1947-48	Actuals for 1947-48	Estimated for 1948-49
Furniture and Office Equipments for Library room reserve fund investment with Imperial Bank	7,500 0 0	258 0 0	5,000 0 0
	64,000 0 0	51,463 5 3	61,950 0 0

CONGRESS ASSOCIATION

Income & Expenditure for 1948-1949

INCOME

	Estimated for 1947-48			Actuals for 1947-48			Estimated for 1948-49		
1. Revenue Income									
Membership Subscription	19,000	0	0	23,828	4	6	25,000	0	0
Publication sales ..	1,000	0	0	1,154	7	6	1.000	0	0
Government of India Grant ..	15,000	0	0	15,000	0	0	15,000	0	0
Grant from N. I. S. C. ..	Nil			1,300	0	0	1,000	0	0
	35,000	0	0	41,282	12	0	42,000	0	0
2. Capital Incomes									
Interest on Reserve fund investment ..	400	0	0	285	15	0	475	0	0
	35,400	0	0	41,541	11	0	42,475	0	0
Deficit	28,600	0	0	9,921	10	3	19,475	0	0
	64,000	0	0	51,463	5	3	61,910	0	0

General Secretary,
Indian Science Congress Association.

PROCEEDINGS
OF THE
THIRTY-SIXTH
INDIAN SCIENCE CONGRESS
ALLAHABAD, 1949

PART II : PRESIDENTIAL ADDRESSES

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ACKNOWLEDGMENT

The cost of printing the Proceedings of the thirty-sixth session of the Indian Science Congress Association has been in part defrayed by a generous grant from the Rockefeller Foundation for the publication of results of scientific work made to us through the kindness of National Institute of Sciences of India.

36th INDIAN SCIENCE CONGRESS, ALLAHABAD, 1949.

SECTION OF MATHEMATICS

PRESIDENT : DR. S. CHOWLA

Presidential Address.

PRIME NUMBERS AND ALLIED TOPICS

1. My object is to give an exposition of selected topics in the theory of primes, the theory of the Riemann zeta and allied functions.

The series of prime numbers is

(P) 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31,...

Euclid proved that there is an infinity of primes. This means that given any number A we can find at least one prime $>$A. Let p_m denote the mth prime. It is a deep result first proved (independently) by Hadamard and de la Valleé—Poussin about the end of the last century, that

$$\lim_{m\to\infty} \frac{P_{m+1}}{P_m} = 1 \tag{1}$$

This is a consequence of the following theorem known as the *Prime Number Theorem*—due to Hadamard and de la Vallee-Poussin:

If $\pi(x)$ is the number of primes $\leqq x$ then

$$\lim_{x\to\infty} \frac{\pi(x)}{x/\log_e x} = 1 \tag{2}$$

From either (1) or (2) one can deduce the following result: given any positive ε there exists at least one prime between x and $x\ (1+\varepsilon)$, for all $x>x_0\ (\epsilon)$. This theorem does not, however, answer the following question Is there always a prime between x^2 and $(x+1)^2$ for $x\geqq 1$. ? This is an unsolved problem. To give another example of an unsolved problem: One notices in the series of primes (*P*) examples of primes p(like 3, 11, 17, 29, 41, 101,...), such that $p+2$ is also a prime number. Are there infinitely many such primes p ?

Riemann introduced the function $\zeta(s)$, where s is a complex variable $=\sigma+it$, in the theory of primes. We define

$$\zeta(s) = 1^{-s} + 2^{-s} + 3^{-s} + 4^{-s} + \cdots \qquad (\sigma>1) \tag{3}$$

Hence

$$2.2^{-s}\ \zeta(s) = 2.2^{-s} + 2.4^{-s} + 2.6^{-s} + \cdots \tag{4}$$

Subtracting (4) from (3) we obtain

(5) $$(1-2^{1-s})\,\zeta(s) = 1^{-s} - 2^{-s} + 3^{-s} - 4^{-s} + - \,..$$

The series on the right is convergent for $\sigma > 0$; it defines an anlytic function of s for $\sigma > 0$; it follows from (5) that there exists a function $\zeta(s)$, which is analytic for $\sigma > 0$ except for a pole at $s=1$, and which satisfies (3). One immediately gets a hint of the connection between the theory of the Riemann zeta function and the theory of primes from the easily-proved relation (valid for $\sigma > 1$)

(6) $$\zeta(s) = \underset{p}{\pi}\,(1 + p^{-s} + p^{-2s} + p^{-3s} + \dots) = \underset{p}{\pi}\,(1 - p^{-s})^{-1}$$

where p runs through all primes.

The famous Riemann hypothesis, which is one of the most exciting unsolved problems of the day, may be stated as follows:

(7) *If* $\zeta(s) = 0$ *for* $0 < \sigma < 1$, *then* $\sigma = \frac{1}{2}$. ?

In view of (5), the Riemann hypothesis may be stated as follows:

(8) *If* $1^{-s} - 2^{-s} + 3^{-s} - 4^{-s} + - \dots = 0 \ (0 < \sigma < 1)$, *them* $\sigma = R(s) = \frac{1}{2}$?

All known complex zeros of $\zeta(s)$ satisfy $R(s) = \frac{1}{2}$. Titchmarsh recently verified that every complex zero s, of $\zeta(s)$ whose imaginary part t satisfies $|t| \leqq 1400$ has the property $\sigma = R(s) = \frac{1}{2}$.

Lehmer and Rademacher propose to extend the examination of complex zeros of $\zeta(s)$ *upto* $|t| \leqq 10^5$. The results of their work are awaited with interest. Should they find a complex zero off the line $\sigma = \frac{1}{2}$ one will have one of the biggest surprises in the history of methematics ! However, it would be a disappointment, it would destroy a beautiful harmony.

The truth of the Riemann hypothesis would have the following consequence in the theory of primes. Let ε be any positive number. Then we would have

(9) $$\pi(x) = \int_2^x \frac{du}{\log u} + O\left(x^{\frac{1}{2}+\varepsilon}\right)$$

It would follow from this result that there is a prime between $x^{2+\varepsilon}$ and $(x+1)^{2+\varepsilon}$ for all large $x > x_0(\varepsilon)$.

However, we are far from the truth of this remarkable conjecture! I shall now introduce Derichlet's L functions. These are functions of the complex variable s defined as follows: We write

$$L(s) = L_k(s) = \sum_1^\infty \chi_k(n)\, n^{-s} = \sum_1^\infty \chi(n)\, n^{-s}$$

where $\chi(n)$ has the following properties :

(i) $\chi(m) = \chi(n)$ if $m \equiv n \bmod k)$

(ii) $\chi(n) = 0$ if $(n, k) > 1$

(iii) $\chi(mn) = \chi m) \chi(n)$ if m, n are any positive integers.

A simple example is

$$L_4(s) = 1^{-s} - 3^{-s} + 5^{-s} - 7^{-s} + - \,.. \qquad (\sigma > 0)$$

It is easy to see that (i) and (iii) are true for $k=4$. One can easily verify (iii) in general. An example is $\chi(3) = -1$, $\chi(5) = +1$, $\chi(15) = -1$, $\chi(15) = \chi(3)\chi(5)$.

More general examples are constructed as follows : We define the Legendre symbol $\left(\frac{n}{p}\right)$ as follows :

If $n \not\equiv 0 \pmod p$, $\left(\frac{n}{p}\right) = +1$ if $x^2 \equiv n \pmod p$ has a solution ;

$\left(\frac{n}{p}\right) = -1$ if $x^2 \equiv n \pmod p$ has no solution.

If $n \equiv 0 \pmod p$, $\left(\frac{n}{p}\right) = 0$.

It is trivial (by definition) that

$$\left(\frac{m}{p}\right) = \left(\frac{n}{p}\right) \text{ if } m \equiv n \pmod p.$$

It is not so easy to prove that

$$\left(\frac{mn}{p}\right) = \left(\frac{m}{p}\right)\left(\frac{n}{p}\right),$$

but it will be a pleasant exercise for any one attracted to the theory of numbers. Then we take

$$\text{(10)} \qquad L_p(s) = \sum_1^\infty \left(\frac{n}{p}\right) n^{-s} \qquad (\sigma > 0)$$

As in the case of $\zeta(s)$ we can prove that

$$L_k(s) = \sum_1^\infty \chi(n)\, n^{-s} = \pi_p \{ 1 - \chi(p)\, p^{-s} \}^{-1} \qquad (\sigma > 1)$$

where p runs through all primes. The so-called extended Riemann hypothesis states that if $L(s)=0$ for a complex s, then we must have $R(s)=\frac{1}{2}$.

It is only a special case of this hypothesis that the series

$$(11) \qquad L_p(s) = \sum_1^\infty \left(\frac{n}{p}\right) .\ n^{-s} \geqq 0 \quad \text{for} \quad s \geqq 0\ ?$$

However, this hypothesis is still unproved. It has not even been proved that

$$L_p(\tfrac{1}{2}) = \sum_1^\infty \left(\frac{n}{p}\right) .\ n^{-\frac{1}{2}} \geqq 0$$

(here p is a fixed odd prime).

In this direction Siegel (*Acta Arith*, Band 1, 1936) has proved the following important result (!I state an important special case)

$$L_p(1) = \sum_1^\infty \left(\frac{n}{p}\right) . n^{-1} > p^{-\varepsilon} \qquad [p > p_0(\epsilon)$$

From this it is easily deduced that:

Let $\varepsilon > 0$ be arbitrary. Then the function $L_p(s)$ has *no zero* in the interval

$$(1 - p^{-\varepsilon}, 1)$$

for all $p > p.(\varepsilon)$. However, the length of this interval tends to 0 as $p \to \infty$, so we get only a little information on the problem (11)! Siegel's proof of this theorem uses difficult class-field theory. I have recently found a proof based only on the classical properties of Dirichlet's L—functions (as expounded in Landan's *Vorlesungen uber Zahlentheoric*).

I recall Goldbach's famous conjecture of 1742: Every even number 2N can be expressed as a sum of 2 primes. This is still unproved. However Vinogradoff proved in 1936 that every *large* odd number can be expressed as a sum of 3 primes. In his proof Vinogradoff used Siegel's theorem as a lemma!

If k is prime to l, Derichlet proved that the arithmetic progression $kx+l$ ($x=1, 2, 3, \ldots$) contains infinitely many primes. An essential part of his argument is based on the theorem :

$$L_k(1) \doteq \sum_1^\infty \frac{\chi(n)}{n} \neq 0$$

But he proved the latter result indirectly—by introducing the theory of binary quadratic forms in his proof.

I shall close this talk by giving Remak's surprisingly eassy proof of the following theorem :

Let k_1 and k_2 be different odd primes.

Write $$L_{k_1}(1) = \sum_1^\infty \left(\frac{n}{k_1}\right) n^{-1}$$

$$L_{k_2}(1) = \sum_1^\infty \left(\frac{n}{k_2}\right) . \; n^{-1}$$

Then at most one of the numbers

$L_{k_1}(1)$ and $L_{k_1}(1)$ is 0

Write $$L_{k_1}(s) = \sum_1^\infty \left(\frac{n}{k_1}\right) n^{-s} .$$

$$L_{k_2}(s) = \sum_1^\infty \left(\frac{n}{k_2}\right) n^{-s}$$

From the prime products for $L_{k_1}(s)$ and $L_{k_2}(s)$ we easily obtain

$$L_{k_1}(s) = e^{\sum \frac{\chi_1(p^m)}{m\,p^{ms}}} \quad \text{where} \quad \chi_1(n) = \left(\frac{n}{k_1}\right)$$

$$L_{k_2}(s) = e^{\sum \frac{\chi_2(p^m)}{m\,p^{ms}}} \quad \text{where} \quad \chi_2(n) = \left(\frac{n}{k_2}\right)$$

Further we define

$$L_{k_1, k_2}(s) = \sum_1^\infty \left(\frac{n}{k_1}\right)\left(\frac{n}{k_2}\right) n^{-s} = e^{\sum \frac{\chi_1(p^m)\,\chi_2(p^m)}{m\,p^{ms}}}$$

Again,

$$\zeta(s) = \sum_{1}^{\infty} n^{-s} = e^{\sum\limits_{p,m} \frac{1}{m\,p^{ms}}}$$

Multiplying these four results we obtain

$$\zeta(s)\, L_{k_1}(s)\, L_{k_2}(s)\, L_{k_1,k_2}(s) = e^{\sum \frac{\{1+\chi_1(p^m)\}\{1+\chi_2(p^m)\}}{m\,p^{ms}}} \qquad (s>1)$$

Since $\{1+\chi_1(p^m)\}\{1+\chi_2(p^m)\} \geqq 0$ it follow that

$$(12) \qquad \zeta(s)\, L_{k_1}(s)\, L_{k_2}(s)\, L_{k_1,k_2}(s) > 1 \qquad (s>1)$$

Now the left side can be written as follows

(on the assumption $L_{k_1}(1) = L_{k_2}(1) = 0$)

$$\left\{(s-1)\right\}\left\{(s-1)\,\zeta(s)\right\}\left\{\frac{L_{k_1}(s)-L_{k_1}(1)}{S-1}\right\}\left\{\frac{L_{k_2}(s)-L_{k_2}(1)}{S-1}\right\}\left\{L_{k_1,k_2}(s)\right\}$$

Now each of the five factors in curly brackets tends to a definite limit as $s \to 1+0$. In fact the first tends to 0, the second tends to 1, the third tends to $L'_{k1}(1)$, the fourth to $L'_{k2}(1)$, the fifth to $L_{k1,k}(1)$. (all, finite limits). Thus the product tends to zero as $s \to 1+0$. This contradicts (12).

[From Landau, Gött. Nachr. 1918]

Linnik recently proved that if $(k, l)=1$, There is a constant c (independent of k) such that, *the least prime* $kx+l$ *is less then* k^c for $k > k_0(c)$.

If the so-called extended Riemann hypothesis is true one can prove the better result that the least prime $kx+l$ is less than k^3 $[k>k_0]$

ADDENDUM

Write

$$\psi(x) = \sum_{p \leqq x} \log p.$$

Recently Atle Selberg gave a direct elementary proof of the result:

$$(13) \qquad \sum_{p \leqq x} \log^2 p + \sum_{p \leqq x} \log p\, \psi\left(\frac{x}{p}\right) \sim 2x \log x$$

This enabled him and Erdös to give *a new proof of the Prime Number theorem* $\left(\pi(x) \sim \frac{x}{\log n}\right)$ which is simple and elementary, and *avoids* using the fact (unlike all earlier proofs) $\zeta(1+ti) \neq 0 \quad (t \neq 0)$.

Using an inequality similar to (13) Atle Selberg was also able to give a new proof (avoiding Derichlet's L-series) of the fact that there are infinitely many primes $\equiv l \pmod{k}$.

Printed by Kalipada Mukherjee at Eka Press, Boranagore.

36TH INDIAN SCIENCE CONGRESS, ALLAHABAD, 1949

SECTION OF STATISTICS

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I. INTRODUCTORY

The instinct to utilise past experience in formulating rules of conduet for the present and future is dominant in the whole realm of animal life. Inductive reasoning is a result of this inherent quality of the human mind. The volume of human experience, accumulated in the past, on analysis and critical study, creates certain impressions in the mind and from this strata of impressions inferences on similar future experiences are made. It has been found that such inferences invariably hold true. The inferences are a function of the experience E and the person who operates. It may for short be represented by I(E,P), E denoting experience and P denoting the person. To be acceptable universally, or at least to the large body of cultured persons, a value for I(E, P) has to be assessed which will be independent of P and which will be true when E is unlimitedly great. Statistical technique is one approach to this problem and naturally therefore, statistical methods have become increasingly important in all fields of human activity.

The personal element is present in everything that one touches. And this personality in the case of well disciplined persons, is found to be more or less an invariant. Poems of Tagore or the paintings of Raphael have the stamp of the respective masters in them. Further, in the field of observations, it has been found that for experienced observers, the personal equation is a constant. In view of these remarks, if it be agreed that only persons who have a well disciplined mind and intellect are alone studying the experience E, the variation in I(E,P) due to P will be small. The process of randomisation—a technique so familiar to the statistician—brings down this variability still further, so that the inferences, subject to these conditions, become a function of E only and may be denoted by I(E). One aspect of statistical technique deals with the evaluation of the limit of I(E).

Limiting processes are essentially mathematical. The mathematician has a technique to evaluate the limit of $f(x)$ as x tends to any value a only if $f(x)$ is expressed explicitly as a function of x. The function I(E), however, cannot be explicitly expressed in terms of E and hence the technique of the mathematician cannot be directly applied. A modification is necessary and this has been achieved.

II. Statistical Population and Sample.

Experience is the result of observation. To simplify observation, consider a set of variables $(x_1, x_2, \ldots x_K)$ denoted for short by x that can be observed repeatedly. The totality of observed values of x constitutes a population. If the number of observations is finite, the population is finite and if an unlimited number of observations on x is possible, the population is infinite. Any finite set of observed values of x is called a sample. An observed value of x gives values to the k variables and may be denoted by

$$x^{(i)} = \left\{ x_{1i},\ x_{2i},\ \ldots x_{ki} \right\} \qquad \text{(i)}$$

and a sample of size n becomes

$$x^{(1)},\ x^{(2)},\ \ldots \qquad x^{(n)} \qquad \text{(ii)}$$

or written in full

$$\begin{Bmatrix} x^{(1)} \\ x^{(2)} \\ \vdots \\ x^{(n)} \end{Bmatrix} = \begin{Bmatrix} x_{11}, x_{21}, & \ldots & x_{k1} \\ x_{12}, x_{22} & \ldots & x_{k2} \\ \cdot \quad \cdot & & \cdot \\ x_{1n}, x_{2n}, & \ldots & x_{kn} \end{Bmatrix} \quad \cdot \quad \cdot \quad \cdot \quad \cdot \qquad \text{(iii)}$$

This set of nk numbers that are observed, corresponds to the experience that has resulted from observation. A mathematical model to this is obtained with the help of a k-dimensional Eucledian space.

Consider k axes OX_1, $OX_2 \ldots OX_K$. In this space, the k values $x^{(i)}$ in (i) may be looked upon as the coordinates of a point P_i. Thus the population becomes equivalent to a set of points W in this space and the sample becomes a subset w of W. Inferences regarding W correspond to the properties of W and the role of statistics is to infer the properties of the unknown W from a study of the known w. This is possible in view of the remarks in section I and hence it may be axiomatically assumed that the properties of the unknown population are conserved in the known or observable sample.

The properties of the sample may be expressed in terms of functions of observed values or, for short, functions over the set w. Such functions have been called statistics. The limits of these functions as w tends to W give the properties of W.

III. Probability.

A machinery has to be constructed to yield the functions over the set *w* and their limits that characterise the unknown W. These results have necessarily to satisfy the human mind. It has therefore to assess numerically the extent of human conviction regarding the results. The question arises "can the degree of human belief be measured". Philosophical implications in answering this question will be considerably great. Opinion will be widely different. However, one solution that will satisfy the human mind may be indicated, the satisfaction coming out of the fact that the machinery will be able to construct in orientation and density the set of points W.

Let $f(x) = f(x_1, x_2 \ldots x_K)$ denote a point function, integrable over the set W. Let S be a subset of W. Denote by F(S) the integral of $f(x)$ over S. Then F(S) is a function over the set S. If further $f(x)$ is assumed to be non-negative, F (S) satisfies the conditions

$$F(S) \geq O$$

$$F(S_1+S_2)=F(S_1)+F(S_2) \text{ provided } S_1 . S_2=O. \qquad \text{(iv)}$$

It will be remembered that S_1+S_2 is the set of points belonging to either S_1 or S_2 and $S_1 . S_2$ is the set of points common to both S_1 and S_2. The relations in (iv) are the same as those for the measure of a set. F (S) defined by

$$F(S) = \int_S f(x)\, dx \qquad \text{(v)}$$

may be called the f—measure of the set S. Further F(S)/ F(W) gives the measure of S relative to W. If it be assumed that $f(x)$ is such that F(W) is unity, F(S) actually denotes the relative measure of S.

The additive property of F(S) in (iv) makes it possible to set up an equivalence between F(S) and the physical concept of weight or content of the set S. Once this equivalence is recognised $f(x)$ may be called a density function, $f(x)\, dx$ giving the content of the set of points in the neighbourhood of x. Hence the set of points W can be completely constructed with the help of $f(x)$. This remarkable property of $f(x)$ gives the guarantee that the properties of the set W may be deduced from those of $f(x)$.

The function $f(x)$ is the probability or density function of S. It will be observed that the only conditions satisfied by $f(x)$ are :—

$f(x) \geq 0$

$\int_S f(x)\,dx$ exists for all subsets S of W.

$$\int_W f(x)\,dx = 1. \qquad \text{(vi)}$$

Though this definition of probability is precise in mathematical form, one gets the uncomfortable feeling that probability is still undefined in so far as $f(x)$ is arbitrary. Herein also lies its importance. The statistician observed a sample (iii) and based on this, chooses an $f(x)$ to represent the probability of x. Professor Fisher has called this problem of constructing $f(x)$ the problem of "Specification". Once $f(x)$ is specified, the start for a logical study of the unknown set W has been made. The constants in $f(x)$ called parameters, are estimated from the sample w and the stability of these estimates in repeated samples is determined. The stability is calculable in terms of probability—low values corresponding to our inferences being exceptional and values near unity indicating concurrence in the long run of experience. In the former case, the function $f(x)$ has to be discarded and fresh start has to be made with another function. This procedure looks as if it is a trial and error technique. In a sense it is certainly so and is probably the only proceedure in getting to know the unknown W. It has to be considered as an iterative process, leading nearer and nearer the truth.

The convergence of these iterative processes is contained in the two remarkable results—the law of Large Numbers and the Central Limit Theorem. These two theorems are the outcome of delicate and dexterous mathematical analysis. In view of their importance in statistical analysis, a brief reference to them is is only proper.

IV. Stochastic convergence and the Law of Large Numbers.

In mathematical analysis, a sequence $x_n = f(n)$ ($n = 1, 2, 3, \ldots \infty$) defines an infinite set W. In certain cases x_n has a unique limit μ. This limit μ is a characteristic of the set W. Consider now a repetitive process, which, for convenience, is the measurement of a variable u. Suppose the totality of u to be infinite in number. If u_i denotes the i-th observation, the infinite sequence u_i ($i = 1, 2, \ldots \infty$) forms a set W. This set however is unknown in the sense that u_i is known only after the physical measurement has been made. Has this sequence a limit ? To discuss this problem, the classical methods of mathematical convergence to a limit are not applicable.

The problem may be stated as follows :—W is an infinite set of values of a variable x and w is a known subset of W with values x_1, x_2, . . x_n . T_n is a known function of the set w and is given by

$$T \;=\; T(x_1, x_2, \ldots x_n) \qquad \text{(vii)}$$

Does T_n tend to a limit as n tends to infinity? The problem is trivial if T_n can take only a finite number of values. Neglecting this, T_n generates an infinite set Z and let p_n (T) denote the probability density associated to this set Z. This p_n (T) gives the clue to evaluate the limit of T_n.

In pure mathematics, T_n will converge to T, if, given any small positive number ε, it it is possible to determine an integer N, such that for $n > N$, T_n will fall in the vicinity V defined by

$$V \equiv \left\{ \left| T_n - T \right| \leq \varepsilon \right\} \qquad \text{(viii)}$$

This definition of convergence of T_n to T, is replaced by convergence in probability or stochastic convergence. Let

$$q_n = P \left\{ V \right\} = \int_V p_n(T)\, dT \qquad \text{(ix)}$$

q_n gives the probability that T_n satisfies the inequality (viii) and can be determined as a function of n. If q_n tends to unity as n tends to infinity, T_n is said to converge stochastically to T.

The evaluation of the integral (ix) may not always be convenient. Attempts to evaluate its limit have led to considerable research in pure mathematics. One of the most powerful methods that has prôved useful in this direction is the method of Steepest Descent. In relation to our problem, the method lies in showing that p_n (T) tends uniformly to zero as n tends to infinity outside the vicinity V (viii), so that the total integral of p_n (T)—which is unity—reduces to the integral over V.

A simpler proceedure—applicable in a majority of cases—is to apply the generalised form of Tchebycheff Theorem. This may be stated as follows :—

If x is a non-negative variable

$$P \left\{ x \geq A \right\} \leq \frac{E(x)}{A} \qquad \text{(x)}$$

where E (x) denotes the mathematical expectation of x and A is any positive number. Putting $E(x) = a$ and $E(x-a)^2 = \sigma^2$, the inequality (x) reduces to

$$P\left\{\left|x-a\right| \geq \varepsilon\right\} \geq \frac{\sigma^2}{\varepsilon^2} \tag{xi}$$

This result may directly be applied to test stochastic convergence. Let $E(T_n) = a_n$ and $E(T_n - a_n)^2 = \sigma_n^2$.

If σ_n tends to zero as n tends to infinity, T_n tends to the limit of a_n.

The condition, $\sigma_n \rightarrow 0$, is satisfied if

$$T_n = (x_1 + x_2 + \ldots x_n)/n \tag{xii}$$

$x_1, x_2, \ldots x_n$ being independent and following the same porbability law with a finite standard deviation. This result is, in essence, the Weak Law of Large Numbers. Improvement of the inequality (xi) with x replacced by T_n in (xii) has been effected and these are contained in the Strong Law of Large Numbers and the Law of Iterated Logarithms.

V. The Central Limit Theorem.

Having briefly discussed the concept of stochastic convergence, an indication to formulate $p_n(T)$ may be given. Though formally

$$p_n(T)\,dT = \int p(x_1, x_2, \ldots x_n)\,dx_1\,dx_2 \ldots dx_n \tag{xiii}$$

$$T \leq T_n \leq T + dT$$

the explicit expression for $p_n(T)$ will depend upon the evaluation of difficult integrals. But it is remarkable that under certain mild conditions, $p_n(T)$ becomes, for large values of n, asymptotic to

$$p(T) = \frac{1}{\sqrt{(2\pi)}\,\sigma} \exp\left\{-\frac{(T-a)^2}{2\sigma^2}\right\} \tag{xiv}$$

This result is the Central Limit Theorem in probability. As a particular case, x_n ($n = 1, 2, \ldots \infty$) denotes an infinite sequence of random variables having

$$E(x_n) = 0 \text{ and } E(x_n^2) = \sigma_n^2.$$

If $T_n = x_1 + x_2 + \ldots + x_n$, it follows that $E(T_n) = 0$ and $E(T_n^2) = \sigma_1^2 + \sigma_2^2 + \ldots + \sigma_n^2 = \Sigma_n^2$

The Central Limit Theorem asserts that under certain conditions, that are not too restrictive, the variable

$$Z_n = T_n / \Sigma_n \tag{xv}$$

tends, as n tends to infinity, to follow the law

$$p(Z) = \frac{1}{\sqrt{2\pi}} \exp\left\{-\frac{Z^2}{2}\right\} \tag{xvi}$$

This elegant and surprisingly beautiful result—the approach to normality of the distribution of the sum of a number of independent variates following arbitraty laws—explains the great importance of the normal law in both practical and theoretical Statistics. Here is also found the justification for large sample theory in tests of significance— the three sigma rule.

The Central Limit Theorem has been stated, in brief, for the case of non-correlated variables. When the variables are correlated, the Central Limit Theorem is as follows :—

Let $x = (x_1, x_2, \ldots x_k)$ be a set of variables such that $E(x_i) = 0$ and $E(x'x) = (\rho)$.

If $x^{(i)}$ $(i = 1, 2, 3, \ldots \infty)$ is an infinite sequence of values of x the covariance of the set $x^{(i)}$ being denoted by $p^{(i)}$ then the set of k variables

$$T_n = \left\{ x^{(1)} + x^{(2)} + \ldots + x^{(n)} \right\} / n \tag{xvii}$$

tends to be distributed according to the normal multivariate law

$$p(T) = \text{constant} \exp\left\{ -\tfrac{1}{2} T (\rho)^{-1} T' \right\} \tag{xviii}$$

where $(\rho) = \frac{1}{n}\left(\rho^{(1)} + \rho^{(2)} + \ldots + \rho^{(n)} \right)$ and $(\rho)^{-1}$ is the reciprocal of (ρ).

VI. The Normal Probability Law.

The normal probability function comes as the limiting form of the distribution of Z_n in (xv). Various attempts to derive the normal law have been made from very early times. It was felt by experimenters that errors of observation follow the normal law. Hagen introduces the concept that any error of observation is the sum total of a very large number of elementary errors, all of the same magnitude. He further assumes that positive and negative errors are equally likely. On this molecular model to an error, Hagen proves that the error law satisfies the differential equation

$$\frac{dy}{dx} = kyx \qquad \text{(xix)}$$

Integration of (xix) gives the normal law.

Another attempt starts from the principle of the arithmetic mean which is first established from a few postulatory assumptions. These interesting brainwaves on the part of eminent men have brought out the famous comment :

"Everybody believes in the exponential law of errors : the experimenters, because they think it can be proved by mathematics ; and the mathematicians, because they believe it has been established by observation":

The normal law has two distinctive properties. The most familiar one is that the sum of two independent normal variates is itself a normal variate. The second, which is probably not so familiar, is that, if the sum of two independent variates is normally distributed, then the two variables are also normally distributed.

The normal probability function, it was stated, is the dominant term in the asymptotic expansion of $p(Z)$. Considerable research has been made to evalute the error term

$$\left| p_n(Z) - \frac{1}{\sqrt{2\pi}} \exp \left\{ -\frac{Z^2}{2} \right\} \right|$$

It has been established that the error is less than $k \log. n / \sqrt{n}$ where k is a constant. It has also been proved that $p_n(Z)$ has the expansion

$$p_n(Z) = \phi(Z) + \frac{a_3}{\sqrt{n}} \phi^3(Z) + \frac{1}{n}\left(a_4 \phi^4(Z) + a_6 \phi^6(Z)\right) + \dots \qquad \text{(xx)}$$

where $\phi(Z)$ is the normal law and $\phi^{(i)}(Z)$ is the i^{th} derivative of (Z). The a—coefficients in (xx) are functions of the semi-invariants of the distributions of $x_1, x_2, \dots x_n$. The expansion (xx) is not the same as the expansion given by the Gram-Charlier series.

The extension of the normal distribution (xiv) to *k* variables is

$$p\,(x_1\,..\,x_k) = \frac{A^{\frac{1}{2}}}{(2\pi)^{\frac{k}{2}}}\ \exp\left\{-\tfrac{1}{2}\left[\sum a_{ij}(x_i - \mu_i)^2 + 2\sum a_{ij}\,(x_i - \mu_i)\,(x_j - \mu_j)\right]\right\}$$

If $x = (x_1\, x_2\, ..\, x_k)$, $\mu = (\mu_1, \mu_2, ..\, \mu_k)$ and $D = (a_{ij})$

the quadratic form in (xxi) can be written

$$(x-\mu)\ D\ (x-\mu)' \qquad \text{(xxii)}$$

and (xxi) can be written

$$p\,(x) = \frac{|D|^{\frac{1}{2}}}{(2\pi)^{k/2}}\, e^{-\frac{1}{2}(x-\mu)\,D\,(x-\mu)'} \ . \qquad \text{(xxiii)}$$

Since the integral of $p\,(x)$ exists the quadratic form (xxii) is positive definite. Matrix algebra is convenient to tackle quadratic forms and naturally matrix methods are useful tools to the Satistician.

VII. Matrices.

Matrices are elegant in the representation of variables. Thus the set of variables $y_1, y_2, \ldots y_n$ given by

$$y_i = \sum_{j=1}^{k} a_{ij}\, x_j \ \text{ for } i = 1, 2, ..\, n \qquad \text{(xxiv)}$$

in matrix notation is concisely denoted by

$$y = x\,A \qquad \text{(xxv}$$

If x and y have the same number of variables and the square matrix is non-singular, the equations give

$$x = y\,A^{-1}$$

where A^{-1} is the reciprocal of A.

In the study of quadratic forms, the elements of the matrix can be assumed to be real numbers. It is well known that a matrix can be reduced to the diagonal form and for symmetrical matrices, this reduction can be carried out with a matrix and its transposed. This property gives a method of reducing a quadratic form to a sum of squares. Thus if

$$H D H' = (g_{ii}) \qquad g_{ij} = 0 \text{ if } i \text{ not} = j$$

the transformation $x = u\,H$ gives

$$x D x' = u H D H u' = u\,(g_{ii})\,u' = \sum g_{ii}\,u_i^{\,2} \qquad \text{(xxvi)}$$

The distribution of the variables (u) becomes

$$p\,(u) = \frac{(g_{11}\,g_{22} \,..\, g_{kk})^{\frac{1}{2}}}{(2\pi)^{k/2}}\, e^{-\frac{1}{2}\sum g_{ii}\,u_i^{\,2}}$$

showing that these variables are independent and that each variable is normally distributed. Even though this technique is familiar to the statistician, it may not be out of place to point out some applications.

Denoting by X_i the variable $x_i - \mu_i$ and by X the matrix $(X_1, X_2, .. X_k)$ the co-variance or dispersion matrix of X is

$$V = E \begin{Bmatrix} X_1^2 & .. & X_1 X_2 & .. & X_1 X_k \\ X_1 X_2 & .. & X_2^2 & .. & X_2 X_k \\ .... & & .... & & .... \\ X_1 X_k & .. & X_2 X_k & .. & X_k^2 \end{Bmatrix} = E\,(X^1 X)$$

$$= \frac{\sqrt{|A|}}{(2\pi)^{k/2}} \int X' X\, e^{-\frac{1}{2} X A X'}\, dX_1 .. dX_k$$

The substitution $X = UH$ where $HAH' = 1$ gives

$$V = \frac{1}{(2\pi)^{k/2}} \int H' U' U H\, e^{-\frac{1}{2} U U'}\, dU_1 .. dU_k$$

$$= \frac{1}{(2\pi)^{k/2}}\, H' \left[\int U' U\, e^{-\frac{1}{2} U U'}\, dU_1 .. dU_k \right] H$$

$$= H'\,H.$$

Since $H A H' = 1$, $A = (H' H)^{-1}$ and hence

$$V = A^{-1} \qquad \text{(xxiv)}$$

Thus the matrix of the quadratic form is the reciprocal of the covariance matrix. Further the distribution of U (= XH) is also normal with the quadratic from $U S^{-1} U'$ where S is the covariance matrix of U. In fact $S = E(U'U) = H' V H$. And

$$US^{-1}U' = XH\,(H^{-1}V^{-1}H'^{-1})\,H'X' = XV^{-1}X' \tag{xxv}$$

Thus the quadratic form is invariant under linear transformations. Also, since a quadratic form can be reduced to a sum of squares by linear transformation of variables, the quadratic form in a normal distribution is a chi-square with *k* degrees of freedom.

These well-known results have been cited to show the elegance and depth of matrix methods. The facility with which heavy theoretical calculations can be formally gone through will be evident from the illustrations given above. Even in numerical calculations, matrix methods are powerful. The simplification of determinants by elementary processes on matrices is only too well-known. To give another illustration, consider the determination of the latent roots of a matrix A. Let t_o be any row matrix and let the result of multiplying t_o by A be the matrix $c_1\, t_1$ where c_1 is a constant introduced to make the first elements of t_o and t_1 the same. Similarly let

$$t_1\, A = c_2\, t_2,$$
$$t_2\, A = c_3\, t_3,$$
$$\cdots\cdots\cdots\cdots$$

where $t_1, t_2, t_3, \ldots$ are row matrices in which the first elements are all the same. The n^{th} multiplication is equivalent to

$$t_o\, A^n = c_1 c_2 \ldots c_n\, t_n\, . \tag{xxvi}$$

If λ_1 is the largest latent root of A and

$$A = P \wedge P^{-1}$$

where $\wedge$ is the diagonal matrix of latent roots

$$A^n = P\, \Lambda^n\, P^{-1} \sim \lambda_1^n\, (p_{ij}\, p^{ji}) \tag{xxvii}$$

as *n* increases. p_{ij} and p^{ji} are the elements of P asd P^{-1} respectively.

From equations (xxvi) and (xxvii) it may be easily seen that as *n* becomes large t_n converges to the first row of P^{-1} and that t_n becomes λ_1. In parctice, this convergence is very rapid and the latent root and the first row of P^{-1} can be simultaneously obtained in a few stages. Having got λ_1, a new matrix A_1

is formed from A by elementary processes in which the largest latent root is the second root of A. By the proceedure outlined, the lartent root of A_1 is calculated. Proceeeding in this way, all the roots of A_1 are obtained. The method is particularly useful in calculating the first few roots.

Thus both to the computer and the theoretical statistician matrix algebra is extremely helpful.

VIII. Vector space and linear approximation.

In the previous section certain methods of matrix algebra that are useful to the statistician have been indicated. Another equally important weapon is the geometry of linear vector spaces which is an extension of the fundamental concepts of three-demensional geometry to more than three dimensions.

The matrix $(x) = (x_1 x_2 \,..\, x_n)$ represents a point X in an n- space S_n and the distance of X from the origin O is $OX^2 = \sum x_i{}^2 = (x x')$

The direction cosines of OX are $(x)/d$. If Y is another point (y),

$$XY^2 = \sum (x_i - y_i)^2 = (x-y)\ (x-y)^1 \tag{xxviii}$$

and the angle X O Y is given by

$$\operatorname{Cos} \theta = \frac{\sum x_i\, y_i}{OX.\ OY} = x y' / \sqrt{(xx')\ (yy)^1} \tag{xxix}$$

The two lines are orthogonal if $xy = 0$.

If $X_1\ X_2 \,..\, X_k$ are k points in S_n, these k points together with the origin form a space S_k in S_n The co-ordinates of any point X in S_k are given by

$$x = a_1 x^{(1)} + a_2 x^{(2)} + \,..\, + a_k\, x^{(k)} \tag{xxx}$$

where $x^{(i)} = (x_{i_1}, x_{i_2}, \,..\, x_{in})$ represents the point X. The set of points (xxx) froms a linear vector space S_k. Any point P whose co-ordinates cannot be represented as in (xxx) is a point outside S_k. The explicit expression for the co-ordinates of X are

$$\begin{aligned} x = (x_1\ x_2 \,..\, x_n) = (a_1\ a_2 \,..\, a_k) & \left\{ \begin{matrix} x_{11}\, x_{12} \,\cdots\cdots\, x_{1n} \\ x_{21}\, x_{22} \,\cdots\cdots\, x_{2n} \\ x_{31}\, x_{32} \,\cdots\cdots\, . \\ \vdots \quad \vdots \qquad . \\ x_{k1}\ x_{k_2} \,\cdots\cdots\, x_{kn} \end{matrix} \right\} \\ = aX & \end{aligned} \tag{xxxi}$$

$OX^2 = xx' = a\,XX'a'$ which is formally the sum of n squares. The matrix can be reduced to the diagonal form $HX\,X'\,H' = 1$ where H is a non-singular matrix of order k. Consider the variables

$$U = (U_1\,U_2 \ldots U_k) = a\,H\,X.$$

Then $OX^2 = UU^1 = U_1^2 + U_2^2 + \ldots + U_k^2$.

Thus the square of vector OX in S_k is the sum of k squares and this sum is said to have k degrees of freedom.

If Y is the point $(y_1 y_2 \ldots y_n)$ outside S_k the distance YX is given by

$$YX^2 = (y - aX)\,(y - aX)' \qquad \text{(xxxii)}$$

If X is chosen so that YX is least, the corresponding point X is called the closest approximation to Y in S_k. The minimising equations are clearly

$$(y - a\,X)\,X' = 0. \qquad \text{(xxxiii)}$$

This equation gives the interesting interpretation that P X is orthogonal to the lines $O\,X_1$, $O\,X_2, \ldots O\,X_k$ and therefore to the space S_k. Thus X is the foot of the perpendicular from Y on S_k and the co-ordinates of X are given by

$$y\,X'\,(XX')^{-1}\,X. \qquad \text{(xxxiv)}$$

Further

$$\left.\begin{aligned} OX^2 &= y(XX')^{-1}y', \\ XY^2 &= y\,[\,1 - (XX')^{-1}]\,y' \end{aligned}\right\} \qquad \text{(xxxv)}$$

The number of degrees of freedom for the sums of squares in (xxxv) are respectively k and $n-k$. Also the variables represented by the vectors O X and XY are non-correlated and hence independent if they follow othe multivariate normal distribution. These remarks correspond to the result of Cochran's Theorem on the decomposition of quadratic forms which can be considered as a statement of Pythogoras theorem :

$$O\,Y^2 = O\,X^2 + X\,Y^2 \qquad \text{(xxxvi)}$$

In terms of quadratic forms this becomes

$$\underset{S_n}{(yy')} = y\,\underset{S_k}{(XX')^{-1}}\,y' + y\,[\,1-\underset{S_{n-k}}{(XX')^{-1}}\,]\,y'$$

and therefore having degrees of freedom

$$n \quad = \quad k \quad + \quad n-k.$$

This geometrical symbolism is indeed a powerful tool. Most of the distributions arising in multivariate analysis can be worked out by this geometrical representation and the purely analytical procedure is very often highly involved and cumbersome. Professor Fisher and subsequently a good body of research workers have very freely used this geometrical method in statistical analysis.

The approach to approximate a vector OY in a k— space is actualy the method of regression. It is also a convenient approach to the mathematical theory of approximation. Consider a function $f(t)$. The n values of $f(t)$ for $t = t_1, t_2 \ldots t_n$ represent the co-ordinate a of point F in n — space. If t takes all values in the interval $a \leq t \leq b$, the infinite set of values of $f(t)$ can be looked upon as representing the co-ordinates of F in a space S of infinite dimensions. The distance of the function $f(t)$ from the origin is now given by

$$OF^2 = \int_a^b \left\{ f(t) \right\}^2 dt$$

provided $f(t)$ is integrable-square in (a, b). With this conceptual representation of a function in S_∞, a set of k functions $f_1, f_2, \ldots f_k$ gives a k— space S_k in S_∞. Any point G in S_k corresponds to a function $g(t)$ which is a linear compound of $f_1, f_2, \ldots f_k$ and is given by

$$g(t) = a_1 f_1(t) + a_2 f_2(t) + \ldots a_k f_k(t) \qquad \text{(xxxviii)}$$

$g(t)$ will be the closest approximation to $f(t)$ if the distance D (f, g) between $g(t)$ and $f(t)$

$$D^2 = \int_a^b \left\{ f(t) - g(t) \right\}^2 dt$$

is least. Thus the a's satisfy the equations

$$\int \left\{ f(t) - g(t) \right\} f_i(t)\,dt = o \quad i = 1, 2, \ldots k \qquad \text{(xxxix)}$$

As in (xxxiii), equation (xxxix) shows that the vector F G is orthogonal to the space S_k. In particular if

$$\int_a^b f_i(t) f_j(t)\, dt = 0 \quad \text{if } i \text{ not} = j$$

$$= 1 \quad \text{if } i = j \tag{xl}$$

$$a_i = \int_a^b f(t)\, f_i(t)\, dt$$

$$= \text{O F Cos F O F}_1$$

and hence is the projection of the f—vector on the f_i—vector.

These illustrations have been cited to stress the simplicity of concepts in the theory of approximation in linear vector spaces. The idea of the degrees of freedom associated to the square of a vector or a sum of squares, presents very little difficulty or confusion of thought, if it is identified with the dimension of the space in which it lies.

The method of approximation, geometrically, reduces to minimising the distance between two points and is called the Principle of Least Squares.

IX. Markoff Theorem.

Closely related to the theory of Least Squares is Markoff Theorem which is familiar to statisticians in the field of linear estimation. If θ is a parameter T is called its best unbassed estimate if

$$E(T) = \theta \text{ and } E(T-\theta)^2 \text{ is least} \tag{xli}$$

The Theorem of Markoff determines estimates statisfying (xli). It may be stated as follows :—**i.** $(x) = (x_1, x_2 \,..\, x_n)$ is a set of n independent variables having the same variance σ^2 and, having expectations

$$E(x) = (\mu_1, \mu_2, \ldots \mu_k..) \left\{ \begin{matrix} a_{11} & a_{12} & \cdot\cdot & a_{1n} \\ a_{21} & a_{22} & \cdot\cdot & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ a_{k1} & a_{k2} & \cdot\cdot\cdot & a_{kn} \end{matrix} \right\}$$

$$= (\mu)(A) \tag{xlii}$$

where (μ) is unknown.

ii. $\theta = \mu q$ where $q = (q_1, q_2 :\ldots : q_k)$ is known (xliii)

iii. The best linear estimate of θ is $T = \xi q'$.
where ξ minimises

$$(x - \xi A)(x' - A' \xi')$$

Further the best estimate of σ^2 is

$$\frac{x\,[\,1 - A'(AA')^{-1}A\,]\,x'}{n-k} \qquad \text{(xlv)}$$

To prove this theorem assume that the best estimate of T is given by $T = bx'$. Then $E(T) = b\,A'\,\mu'$. Hence if b satisfies the equation

$$b\,A' = q \qquad \text{(xlvi)}$$

T is an unbiassed estimate. Variance of T is $\sigma^2 b\,b'$. Minimising this, subsect to (xlvi)..

$\sigma^2 b = \lambda A$ where $\lambda = (\lambda_1, \lambda_2 \ldots \lambda_k)$ are a set of Lagrangian multipliers. Hence

$$\sigma^2 q = \lambda\,(AA') \qquad \text{(xlvii)}$$

If the matrix (AA') is non-singular,

$$b = q\,(AA')^{-1}A$$
$$T = q\,(AA')^{-1}A\,x'$$

To show that this gives the theorem, it will be noted that (xliv) is a minimum if ξ satisfies

$$(x - \xi A)\,A' = O.$$

which gives $\xi = x\,A'\,(AA')^{-1}$ and hence

$$T = x\,A'\,(AA')^{-1}q\,.$$

Also the minimum value of (xliv) is

$$x\,[I - A'(AA')^{-1}A\,]\,x' = S_c$$

It will be seen that S_0 is a quadratic form with $n-k$ degrees freedom and hence the best estimate of σ^2 is given in (xlv).

If (AA') is singular, let δ denote any solution of $q = \delta\ (AA')$. Then the best estimate of θ is

$$T = \delta\ A\ x'.$$

clearly $E\ (T) = \quad A\ A'\ \mu' = q\ \mu'$.

If it be assumed that equations $x\ A' = q$ are compatible, the value of ε that minimises (xliv) is δ and hence the theorem. It may be proved that if δ_1 and δ_2 are any two values of δ satisfying $q = \delta\ (AA')$, the corresponding values of T are indentical.

Markoff Theorem, from geometrical considerations, has been evolved by Dr. R. C. Bose and in his most interesting address to this section, two years ago, he has elucidated the applications of this theorem to problems of Design of Experiments.

X. Estimation.

The theory of estimation in statistics is indeed too wide to be introduced here. But it will be noted that most of the methods of estimation can be reduced to the principle of equating a numerically calculable property of the distribution to its value in an observed sample. The method of moments or the method of precentiles follows this principle. Taking the method of Maximum Likelihood, it will be noted that if the limits of the variable x are independent of the population parameter θ in the distribution $p\ (x,\theta)$ and if $p\ (x,\theta)$ admits of differentiation under the integral sign,

$$\int \frac{\delta p}{\delta \theta}\ dx = 0$$

i,e.,
$$\int \left[\frac{\delta}{\delta \theta} \log p\ (x,\ \theta)\right] p\ (x,\ \theta)\ dx = 0$$

or
$$E \left(\frac{\delta}{\delta \theta} \log p\right) = 0$$

The corresponding property in the sample is

$$\Sigma \frac{\delta}{\delta \theta} \log p\ (x_i,\ \theta) = 0$$

which is the Method of Maximum Likelihood.

The arbitrariness noticeable in the methods of estimation has been considerably removed by Professor Fisher who with his characteristic insight studied the problem and formulated the conditions of consistency, sufficiency and efficiency that the best estimates should satisfy. These conditions, in majority of cases, uniquely determine the estimates. Further, the Method of Maximum Likelihood, at least in large samples, leads to estimates that satisfy the conditions of consistency and efficiency.

XI. Summary.

The objects of this lecure has been to explain certain aspects of mathematical procedure in statistical theory. Several important topics like Sequential Analysis, Quality Control, Random Processes and many more in the field of Applied Statistics have been left untouched. This lecture has been directed only towards elementary principles.

Statistical technique has become a necessity for applied research. It can be given a logical set up, if, for any particular situation, the axiomatic assumption of a distribution function is made. The concept of convergence in mathematical analysis is replaced by stochastic convergence. Under general mild conditions the stochastic convergence of a sum gives the Law of Large Numbers. The distribution of a sum of random variables will differ with particular situations ; but, once again, under certain conditions, the dominant term in the distribution of a sum becomes the familiar Normal Distribution Function.

The Method of Least Squares is classical both in statistics and pure mathematics. Geometrical symbolism and the analytic method of Matrix Algebra gives elegance to the application of the Method of Least Squares to problems of approximation and distribution.

Bibliography has not been given. Any one interested has only to refer to the exhaustive compilation by Kendall in his remarkable book on Advanced Statistics or to the refreshing volume on Statistics by Cramer.

36TH INDIAN SCIENCE CONGRESS, ALLAHABAD 1949.

SECTION OF PHYSICS

PRESIDENT : DR. R. S. KRISHNAN, M.A., D.Sc., Ph.D. (Cantab.), F.A.Sc.

Presidential Address

RAMAN SPECTRA OF CRYSTALS AND THEIR INTERPRETATION

I wish to express my sincere thanks for the honour you have done me in electing me to preside over the Physics Section of the Indian Science Congress this year. It is an honour which I greatly appreciate. The subject of my address today is "Raman spectra of crystals and their interpretation," a problem in which I have taken a keen interest during the past five years.

1. INTRODUCTION

It was the late Lord Rutherford (1) who remarked in the course of his Presidential address to the Royal Society (1930) that the Raman effect "has proved and will prove an instrument of great power in the study of the theory of solids." Its universal applicability, the simplicity of the technique, the precision of the results obtained and the ease of their interpretation make the Raman effect a powerful tool for the study of the structure of matter. The information yielded by Raman spectra has been of great value in the investigation of relatively simple molecules as well as of the more complicated polyatomic ones. Its utility in the investigation of the physico-chemical problems set by the crystalline state of matter is equally great. During the several years which elapsed since Rutherford made the remark, numerous papers have appeared on the Raman spectra of crystals. They may be placed broadly in two divisions, namely those in which the emphasis is respectively on the chemical and physical aspects of the subject. More investigations belong to the former group than to the latter. Thus very little progress was made in using Raman effect data for the elucidation of the physical properties of solids. This state of affairs may be attributed to the fact that the physics of the solid state was dominated for many years by theories which had their birth before the discovery of the Raman effect. The reference here is to the well-known theories of solid behaviour originally put forward about the same time by Debye and by Max Born.

It is a significant fact that, subject to some noteworthy qualifications and exceptions, the modes of atomic vibration appearing in the Raman spectra of crystals are represented by sharp lines irrespective of the nature of the substance or of the nature or frequency of the vibrations. In his address to the Faraday Society Sir C. V. Raman (2) pointedly drew attention to this feature and suggested that the monochromatism of the atomic vibrations is a characteristic consequence of the regular ordering of the ultimate particles in the crystalline state of matter. In the year 1941, he (3) returned to this subject and put forward a new theory of specific heat in which the basic notions of the Debye and Born treatments were rejected as untenable. Two years later, Sir C. V. Raman (4) formulated a new theory of the lattice dynamics to which a detailed reference will be made later in the address. The new theory leads among other things to the most important result, namely the vibration spectrum of a crystal consists essentially of a finite number of discrete frequencies. The experimental confirmation of this prediction became a matter of fundamental importance for the progress of crystal physics. The available data on the Raman spectra of crystals were insufficient to give a decisive answer to the issues raised by the new lattice dynamics. It therefore became necessary to carry out a series of investigations designed expressly to elucidate the fundamental aspects of crystal physics. This was undertaken by me in 1943. Using an improved experimental technique for exciting the Raman spectra, many crystals (5) have been studied by me during the last five years and a rich harvest of results obtained in every one of the cases investigated. In this address I shall review briefly the important results achieved in the case of a few typical crystals and their theoretical significance.

2. TECHNIQUE OF STUDY

The scattering of light in crystals is in general a feeble phenomenon. Crystals therefore exhibit weak Raman spectra compared to liquids. Besides, in many crystals because of the high symmetry, the atomic vibration frequencies are forbidden to appear as fundamentals in the Raman effect. They can manifest themselves only as octaves and combinations in the second order Raman effect. The overtone and combinational lines are ordinarily very weak. Hence to record a satisfactory Raman spectrum of a crystal it is necessary to use good specimens and intense sources of excitation. Except quartz and calcite, most crystals cannot be obtained in the form of large lumps for experimentation. In many cases one had to be satisfied with very small specimens. Even with tiny crystals, the spectra could be satisfactorily recorded by giving sufficiently long exposures, provided they are clear, transparent and free from flaws of any kind. This is seldom realised in practice and the light scattered by the specimen is usually mixed with parasitic illumination. Under such circumstances, with moderate exposures the photographic plate gets fogged in the vicinity of the exciting line thus preventing Raman lines with small frequency shifts from being observed.

It has been the practice generally to use the λ 4046 and λ 4358 radiations of the mercury arc as exciter in the studies on the Raman spectra of crystals. The Raman lines excited by these radiations fall in the very region where the weak flourescence exhibited by many crystals appear and where the spectrum of the mercury arc itself shows a weak continuum. Consequently feeble Raman lines may not be detected as they will be overpowered by the continuum. Besides, both λ 4046 and λ 4358 radiations have companion lines in the mercury spectrum. In spite of the fact that the companion lines are of relatively feeble intensity, they do act as exciters for the intense Raman lines thereby creating complications in the recorded spectra. In view of these difficulties, the technique of using the λ 4046 and λ 4358 radiations of the mercury arc for the study of the Raman effect in crystals appeared to have already been pushed to the limit of its utility during recent years. It became clear that some radical improvement in the technique of study had to be effected in order to get further useful information about the Raman spectra of crystals. This was achieved by employing the so-called ultra-violet technique which is described in some detail below.

In Raman effect studies generally and especially in investigating crystals which exhibit only feeble Raman spectra, it is essential to employ a light source which emits the most intense possible and highly monochromatic radiation, and that there should be no unwanted radiations and certainly no continuous spectrum accompanying the same. Further, the use of intense radiation for excitation is accompanied by certain complications, *viz.*, a general blackening of the photographic plate due to diffuse general illumination inside the spectrograph, as also spurious lines and wings in the immediate vicinity of the exciting line arising from the diffraction effect present in any optical instrument, the intensity of which is directly proportional to the brightness of the exciting radiation falling on the slit. This would make it impossible to record faint Raman lines with small frequency shifts. It is therefore highly desirable that the exciting radiation and not the excited one should be removed from the light scattered by the medium before its entry into the spectrograph. All these advantages could be secured by employing the λ 2537 resonance radiation of mercury vapour under special conditions which ensured that only this radiation and none other would give an observable Raman effect. The technique consists in using a low pressure quartz mercury arc in which the mercury vapour is prevented from reaching any considerable density and from absorbing the λ 2537 radiation emitted by itself. This is accomplished firstly by very effective water cooling and secondly by squeezing the discharge against the walls of the quartz tube by the field of a specially designed electromagnet. A filter of mercury vapour at room temperature is placed in the path of the scattered light emerging from the substance under study to absorb the λ 2537 radiation. This filter works so effectively that some of the feeble mercury lines which have intensities negligibly small in comparison with the λ 2537 radiation and which therefore give no observable Raman effect nevertheless appear stronger than the λ 2537 line in the recorded spectra.

The enormously increased scattering power of the resonance radiation arising from the λ^{-4} law as compared with the λ 4046 and λ 4358 radiations has made it an ideal source for Raman effect studies. Further, the use of the λ 2537 radiation enables the high dispersive and resolving powers which even small quartz spectrographs possess in the ultra-violet region to be used with best advantage. The importance of this in the study of Raman spectra exhibiting numerous closely spaced lines can scarcely be overstressed.

Rasetti (6) was the first to use this technique for the study of the Raman effect in gases and in crystals. Thirteen years later Roop Kishore (7) also employed the same technique for Raman effect studies. Neither Rasetti nor Roop Kishore fully utilised the power of the new technique. During the past five years I have succeeded in developing the ultra-violet technique of studying the Raman spectra of crystals to such a degree of perfection that using this technique with a medium quartz spectrograph and a diamond weighing only a few carats, the principal Raman line of diamond could be recorded with an exposure of just five seconds.

3. THEORETICAL BACKGROUND

Before I proceed to describe the experimental results, it will probably be useful to state the issues which need settlement to consider them against the appropriate theoretical background.

Historically, the subject of the scattering of light in material media was first approached by theorists from two distinct points of view. The first point of view due to the late Lord Rayleigh, is that in which the individual particles of which the medium is composed, *e.g.*, the molecules of a gas, are considered to be the agents responsible for the phenomenon. The other point of view, first put forward by Einstein and later elaborated by Leon Brillouin, is that in which the medium is regarded as a continuum and the diffusion of light is ascribed to the "reflection" of the light waves by the sound waves of thermal origin assumed to be present and traversing it in all directions. Which of these points of view is the more appropriate one clearly depends on the circumstances of the case, and is an issue to which experimental study is capable of returning a decided answer. For instance, in a gas, the Rayleigh point of view is the correct one, as is clearly shown by the fact that when we examine the light diffused by hydrogen gas with a Fabry-Perot etalon, we observe a broadening of the spectral lines which corresponds to the Maxwellian distribution of velocities of translation of the molecules (C. S. Venkateswaran (8)). On the other hand, a similar examination of the light diffused by ethyl and methyl alcohol clearly shows a splitting of the spectral lines into two polarised components, their separation varying with the angle of observation (Sunanda Bai (9)). Surprisingly enough, the same phenomenon is also observed in the highly viscous liquid glycerine (C. S. Venkateswaran (10)). From these observations we shall certainly be justified in inferring that liquids exhibit a *coherent modified scattering of light* which may be regarded as a Raman effect due to pulsations of optical density occuring in phases definitely correlated with each other in adjacent volume elements of the medium. Alternatively, we may regard the spectral components as due to the Doppler shifts of frequency arising from the reflection of the light waves by moving sound waves. But we would clearly not be justified in extending such notions to the consideration of the optical effects due to the rotation and vibrations of the molecules in a liquid. For explaining the large spectral shifts arising from such rotations and vibrations which are actually observed with liquids, we naturally go back to the Rayleigh point of view, and consider the individual particles in the medium as the responsible agents. For, the dynamics of such rotation and vibration is essentially a matter of the individual behaviour of the molecules, though indeed they may be influenced and partly modified by the interactions occurring between a molecule and its immediate neighbours.

Coming now to consider the case of crystals, it is a fact of observation that free and practically undamped propagation of elastic waves is possible in them. It is also known that in transparent crystals such waves give rise to optical effects whose strength is determined by their piezo-optic constants. There is therefore no reason to doubt that elastic waves of the three different possible kinds and of various wave-lengths, both larger and smaller than the wave-length of light, exist in crystals as the result of thermal agitation and that such waves give rise to optical stratifications of the same wave-length. But these optical stratifications cannot give rise to any observable scattering of light, unless their wave-length and orientation in relation to the direction of travel of the incident light waves is such as to give rise to a coherent reflection of the latter by the successive stratifications. The optical effects of all other stratifications would cancel out by interference. It follows *that the elastic waves of thermal origin would not give rise to any observable effect in the spectrum of light scattering*, except that which appears with small frequency shifts in the nature of Doppler effects in the immediate vicinity of the incident radiation.

While the continuum point of view is thus appropriate enough in considering the low frequency or elastic vibrations, dynamical principles and the observed experimental facts alike suggest that the particle point of view is the correct approach in respect of the vibrations of high frequencies appearing in the Raman spectrum. For, the high frequencies are themselves an indication that the vibrations are those of the individual atoms in the cells of the structure and not those of microscopic volume elements in the crystal. Hence, the problem is one in particle dynamics analogous to the problem of the vibration spectra of polyatomic molecules and the results to be expected would be of a similar nature, *viz.*, a set of monochromatic frequencies, thus affording a natural explanation of the observed fact that crystals exhibit Raman spectra consisting of discrete lines. This is, in fact, the approach to the subject made in the theory of the vibration spectra put forward by Sir C. V. Raman (1943), in which it is shown that a crystal containing p-atoms in each of its unit cells would have in general (24p – 3) fundamental modes of atomic vibration with monochromatic frequencies. Of this number, (3p – 3) modes may be described as oscillations of the p-interpenetrating atomic lattices of which the crystal is composed, while the remaining 21p modes are oscillations with respect to each other of the various important planes of atoms in the crystal. The number of distinct frequencies may be considerably reduced when the crystal has a very high degree of symmetry. Both the number of and expressions for the frequencies and the geometry of the modes have been fully worked from symmetry considerations in the case of simple structures by Sir C. V. Raman (11) and by K. G. Ramanathan (12). For instance, a structure of the diamond type has eight fundamental frequencies, of the rock-salt type nine, of the caesium chloride type eleven, of the fluorspar type fourteen, and so forth.

On the other hand, the well-known theory of Debye, and the lattice theory of Born and Karman are both based on the belief that the ideas of continuum physics can be applied in respect of the high or infra-red frequencies of vibration of solids. In fact, the Born-Karman theory expressly assumes the existence of "optical waves" of such high frequencies. In the belief that a crystal containing N atoms necessarily possesses *3N different* frequencies of vibration, the theory postulates also that the "optical wave-lengths " form a triply harmonic sequence in the same way as the acoustic wave-lengths. The vast majority of the wave-lengths thus assumed to exist are comparable with the lattice spacings of the crystal and as a consequence, the vibrations postulated in the theory have a diffuse continuous spectrum of frequencies spread over a wide range and not a set of discrete lines as actually observed in the Raman effect. An escape from this obvious contradiction with the facts is sought by means of the assumption that the entire continuous spectrum is rendered inaccessible to observation by reason of optical interference except only those frequencies which possess the right wave-length to give a coherent reflection, as in the case of the acoustic vibrations. We need not here stop to discuss the validity of this suggested explanation of the validity of the basic postulates on which the Born-Karman theory rests, since, as we shall see, the experimentally observed facts in the case of diamond give the answer to both of these questions. It will suffice here to state the points at issue which have to be settled by experiment.

I. Are the vibrations in crystals which manifest themselves in the Raman spectrum, "waves" extending through the volume of the crystal, or are they the vibrations of the atoms in the individual cells of the lattice ?

II. Is the complete vibration spectrum of the crystal in the infra-red region a continuous diffuse spectrum, or is it a discrete spectrum exhibiting a finite set of monochromatic frequencies ?

4. THE EXPERIMENTAL FACTS

I shall now briefly describe the various features observed in fully exposed spectra of the scattered light in a few typical crystals of the diamond, rock-salt and caesium chloride types and also in alumina and topaz. Each type will be considered separately and the theoretical significance of the results obtained will also be discussed.

Diamond :

A heavily exposed Raman spectrum of diamond is reproduced in figure 1. An enlarged print showing the second-order spectrum is reproduced in figure 2. The frequency shifts observed in diamond are of three kinds, namely the Brillouin shifts in the vicinity of the exciting radiation due to thermal waves in the medium, a single Raman line with the shift of 1332 cm^{-1} belonging to the first order spectrum and a series of lines with frequency shifts extending from 2176 to 2666 cm^{-1} and forming the second order spectrum. The most striking feature noticeable in the second order spectrum is the appearance of a whole series of sharply defined Raman lines clearly resolved from one another. The prominent ones have been marked in the figures. It is very significant that no limit or trace of the continuous spectrum of elastic vibrations forming the so-called "acoustic branches" of the lattice spectrum of the crystal appears on the plate even with the longest exposures, whereas the discrete nature of the atomic vibration spectrum in the upper ranges of frequency is clearly manifested in the second order Raman effect. This is a contradiction of the conclusions regarding the nature of the atomic vibration spectra of crystals to which the theories of Debye and Born lead.

The appearance of several discrete frequencies in the second order spectrum of diamond finds a natural explanation in the new theory of lattice dynamics put forward by Sir C. V. Raman. According to the Raman theory, diamond has nine fundamental modes of oscillation of which two have identical frequencies. The vibration spectrum of diamond has therefore eight numerically different vibration frequencies. If ν_1, ν_2, ν_3, ν_4, ν_5, ν_6, ν_7 and ν_8 are the frequencies arranged in the descending order of magnitude, their degeneracies are respectively 3, 8, 6, 4, 3, 3, 4, 6 and 8. Of these, the highest frequency corresponds to the triply degenerate vibrations of the two interpenetrating Bravais lattices of carbon atoms and is active in the Raman effect. It has a value of 1332 cm^{-1}. The other seven frequencies represent the oscillations of the layers of carbon atoms parallel to the faces of the octahedron or cube occurring normal or tangential to these planes with the phases reversed at each successive equivalent layer. All these seven modes are inactive in the Raman effect as fundamentals. They may, however, appear in the second order Raman spectrum as octaves and combinations.

Coming now to the identification of the Raman lines appearing in the second order spectrum, the terminal line with a frequency shift of 2665 cm^{-1} is obviously the octave of the principal mode of oscillation. It is important to note that the frequency shift of this line is very nearly double that of the 1332 Raman line. This fact suggests that the mechanical anharmonicity factor for this particular mode of vibration is small. From theoretical considerations based on the intensities of the Raman lines, it is possible to identify the lines with frequency shifts 2502, 2460, 2297, 2176 and 2105 cm^{-1} as octaves of the modes of vibration ν_2, ν_3, ν_4, ν_5 and ν_6 respectively. See the papers by Sir C. V. Raman (11) and by K. G. Ramanathan (12). The remaining two modes, namely ν_7 and ν_8 have low frequencies and their octaves are not observed in the second order spectrum. The frequencies in wave-numbers of the first six modes are as follows:— $\nu_1 = 1332$, $\nu_2 = 1250$, $\nu_3 = 1232$, $\nu_4 = 1149$, $\nu_5 = 1088$ and $\nu_6 = 1008$ cm^{-1}. The other prominent lines can be satisfactorily explained as combinations of the fundamental frequencies. Some of them are split due to the removal of degeneracy by anharmonicity and due to resonance effect.

The Rock-salt type— The two crystals of the rock-salt type which have been investigated in some detail are sodium chloride and potassium bromide. The sodium chloride used was a natural crystal of rock-salt, while the potassium bromide was a synthetic one. Figure 3*a* is a reproduction of the photograph of the Raman spectrum of rock-salt taken with a large Hilger quartz spectrograph. Figure 3*c* represents the spectrogram of potassium bromide taken with a medium quartz spectrograph, while figure 3b represents that taken with the large quartz spectrograph. Unfortunately in the latter case, as a result of prolonged exposure to the rays of the mercury arc, the crystal acquired a distinct colouration and a diminished transparency and the spectrum was therefore not recorded with the full intensity hoped for. On a scrutiny of the recorded spectra, it is clear that the spectra of both NaCl and KBr consist essentially of a series of discrete Raman lines. These naturally appear more clearly resolved from each other with the larger instrument. The positions of the prominent lines with their frequency shifts in wave-numbers from the exciting line are indicated in the figures. The sharpness of some of the Raman lines, especially 235 and 350 cm^{-1} in the case of NaCl and 84, 126, 146 and 216 cm^{-1} in the case of KBr is comparable to that of any mercury line. The discrete character of the Raman spectrum is more clearly evident in the case of potassium bromide than in the case of rock-salt. This is a complete refutation of the suggestion made in some quarters that the Raman spectrum of the alkali halides is a continuum with some super-imposed peaks or maxima.

According to the new lattice dynamics, a crystal with the rock-salt structure has nine eigenfrequencies. These may be evaluated (11) to a first approximation with the aid of two assumed force-constants only. The theoretically computed frequencies for NaCl and KBr and those evaluated from the observed spectra are shown for comparison in Table I. It will be seen that the agreement is quite satisfactory. ν_3 in the Table is the frequency of the oscillation of the two interpenetrating lattices against each other. The values obtained are in good agreement with the infra-red absorption maximum at 164 cm^{-1} for NaCl and at 113 cm^{-1} for KBr recorded by Barnes (13). As is to be expected, in view of the high refractivity of the anions, the two most intense lines in the Raman spectrum are the octaves of ν_6 and ν_7, *viz.*, of the oscillations (alternately in opposite phases) of the layers of anions in the octahedral planes of the crystal in directions respectively normal and tangential to these planes, the intervening cation layers remaining at rest.

TABLE I

NaCl : $P = 2.422 \times 10^4$ dynes/cm. $T = -0.053 \times 10^4$ dynes/cm.

KBr : $P = 2.22 \times 10^4$ dynes/cm. $T = -0.034 \times 10^4$ dynes/cm.

Mode	NaCl		KBr	
	Calculated cm^{-1}	Obtained cm^{-1}	Calculated cm^{-1}	Obtained cm^{-1}
ν_1	172	175	121	121
ν_2	164	167	117	116
ν_3	157	150	112	114
ν_4	145	143	104	108
ν_5	128	129	95	93
ν_6	117	117	73	73
ν_7	103	101	67	63
ν_8	70	67	40	42
ν_9	50	43	28	23

The caesium chloride type—Ammonium chloride and ammonium bromide crystallise in the cubic system, their structure being similar to that of caesium chloride at ordinary temperatures.

The study of the effect of temperature on the Raman spectra of ammonium halides offers a means of settling two fundamental issues connected with these solids, namely (1) behaviour of the NH_4 ions in the neighbourhood of the transition temperature and (2) the nature of the lattice spectrum in which NH_4 ions oscillate as single units. The Raman spectra of NH_4Cl and NH_4Br and the variation with temperature have therefore been investigated in some detail and some interesting new results have been obtained. In this address I shall confine myself to the low frequency or lattice spectra of NH_4Cl and NH_4Br which have been satisfactorily recorded for the first time. It will be seen from the reproductions (figures 4a and 4b) that the lattice spectra of the ammonium halides exhibit a set of discrete Raman lines. Their frequency shifts are marked in the figures. The lattice spectra of both these crystals exhibit marked variations with temperature.

The appearance of low frequency Raman lines constituting the lattice spectrum with great intensity in crystalline NH_4Cl and NH_4Br at temperatures above the λ-point transition, does not support Pauling's hypothesis that there is onset of free rotation of the NH_4 ions immediately above the λ-point. If the NH_4 ion is capable of free rotation and in consequence possesses spherical symmetry, none of the atomic vibrations of NH_4Cl and NH_4Br in which NH_4 moves as a unit should appear as fundamentals in Raman effect due to the similarity of its structure to that of caesium chloride. The slight mis-setting of the hydrogen tetrahedra during oscillations makes all the lattice vibrations of the structure in which NH_4 moves as a unit, active in the Raman effect. This enables us to observe directly the discrete nature of the vibration spectrum of the caesium chloride type of structure. On the basis of the new dynamics, caesium chloride structure has eleven fundamental modes of oscillation. To a first approximation the eleven modes have only 7 distinct frequencies, ν_1 to ν_7. These may be evaluated (12) with the aid of two assumed force-constants P and T only. The theoretically calculated frequencies for NH_4Cl and those observed in the lattice spectrum are shown for comparison in Table II. Considering the approximations made in the calculation, the agreement between the theoretical and observed values is satisfactory.

TABLE II

NH_4Cl : $P = 2.176 \times 10^4$ dynes/cm. ; $T = -0.07 \times 10^4$ dynes/cm.
Lattice Spectrum of NH_4Cl at 268° T.

Mode	Frequency	Calculated cm^{-1}	Observed cm^{-1}
I	ν_1	179	195
II	ν_2	170	170
III	ν_3	150	152
IV			
V	ν_4	139	141
VI			
VII	ν_5	107	107
VIII			
IX	ν_6	98	92
X			
XI	ν_7	42	

Alumina and Topaz—These two well-known crystals are of great interest from the point of view of our present studies, as their vibration spectra play an important role in the luminescence and absorption spectra exhibited by minerals in which these form the ground material. Deutschbein (14) had investigated in detail the emission and absorption spectra of alumina and topaz containing chromium phosphors both at room temperature and at liquid air temperature. Raman effect data, on the other hand, were very meagre. The complete Raman spectra of these crystals have now been photographed by me using the ultra-violet technique. Seven frequency shifts have been recorded with alumina and thirty-two with topaz, as compared with two and eleven frequency shifts respectively reported by the earlier authors. The structure of alumina belongs to the trigonal class, while that of topaz to the orthorhombic class. The larger number of atoms in the unit cell and the lower crystal symmetry of topaz evidently result in a much larger proportion of the possible modes of vibration being active in light-scattering than in the case of alumina. The Raman spectrum of topaz is reproduced in figure 5.

The chart of the luminescence spectrum of topaz is reproduced in figure 6. This is taken from the paper by Deutschbein (14). A comparison of the frequency shifts from λ 2536.5 as observed in light-scattering and from λ 6824.9 (the principal chromium line) as observed in luminescence shows a most remarkable concordance. The bands observed in the emission spectrum of ruby and also those observed in its absorption spectrum have been successfully explained on similar lines in terms of the vibration frequencies of alumina observed in Raman effect and in infra-red absorption. In fluorescence and absorption, the lattice vibrations appear as diffuse bands and not as sharp lines. This is true even at low temperatures. The broadening may be explained on the basis that the loading of the lattice by the chromium ions gives rise to a perturbation of the vibrational modes. Part of the broadening may be attributed to the fact that the principal electronic lines themselves have a finite width.

It may be remarked that in luminescence and in the Raman effect, the vibrations of the crystal lattice are excited by entirely different mechanisms, and yet, as we have seen, there is complete correspondence between the frequency shifts of the vibrational bands appearing in luminescence and the Raman effect. This result is very significant and has far-reaching consequences. According to the Born lattice dynamics, the appearance of sharp lines in the first order Raman spectrum of any crystal is explained as due to some kind of a selection rule which picks out only certain frequencies from the continuous vibration spectrum of the lattice. There is no reason to suppose that the same kind of selection rule should be operative in luminescence also. In fact, the entire vibration spectrum should appear as a continuous band in emission without showing any fine structure of the kind actually observed. It follows therefore that what is actually recorded in luminescence and in Raman effect indicates the real nature of the vibration spectrum, namely that it consists of a set of discrete frequencies.

5. CONCLUDING REMARKS

From the experimental facts summarised in the preceding section, it is clear that the parts of the vibration spectrum in the lower and upper ranges of frequency differ radically in their behaviour. The first part is totally inactive in light-scattering, while the second part is strongly Raman-active, giving an intense second order spectrum. The character of the spectrum is also totally different in the two ranges of frequency. While the spectrum of the elastic vibrations is necessarily a continuous one, the discrete nature of the atomic vibration spectrum in the upper ranges of frequency is clearly manifested in the second-order Raman effect; the overtones and summations of the primary vibration frequencies appear under adequate instrumental power clearly resolved into numerous closely spaced sharp lines. These differences are fundamental and compel us to recognize that the two parts of the vibration spectrum are physically of a different nature. In the lower ranges of frequency, we are concerned with elastic waves traversing the crystal from end to end and forming stationary wave-patterns, while in the upper ranges of frequency, we are concerned with the vibrations of the atoms in the individual cells of the crystal lattice. The spectroscopic facts thus give a decisive answer to the theoretical issues stated at the end of the 3rd section. They show that the assumptions on which the Debye and Born-Karman theories are based are unjustified and that the conclusions regarding the nature of the atomic vibration spectra to which those theories lead are altogether untenable.

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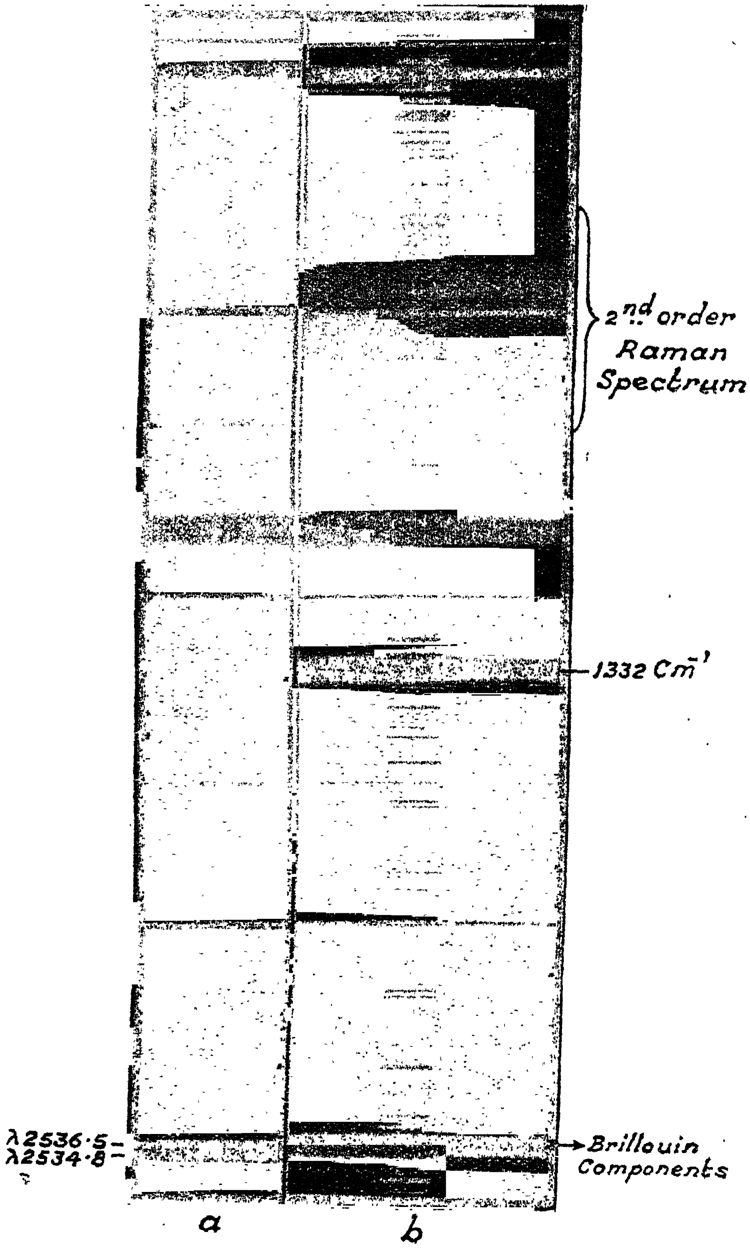

Fig. 1. The complete Raman spectrum of diamond taken with a medium quartz spectrograph.

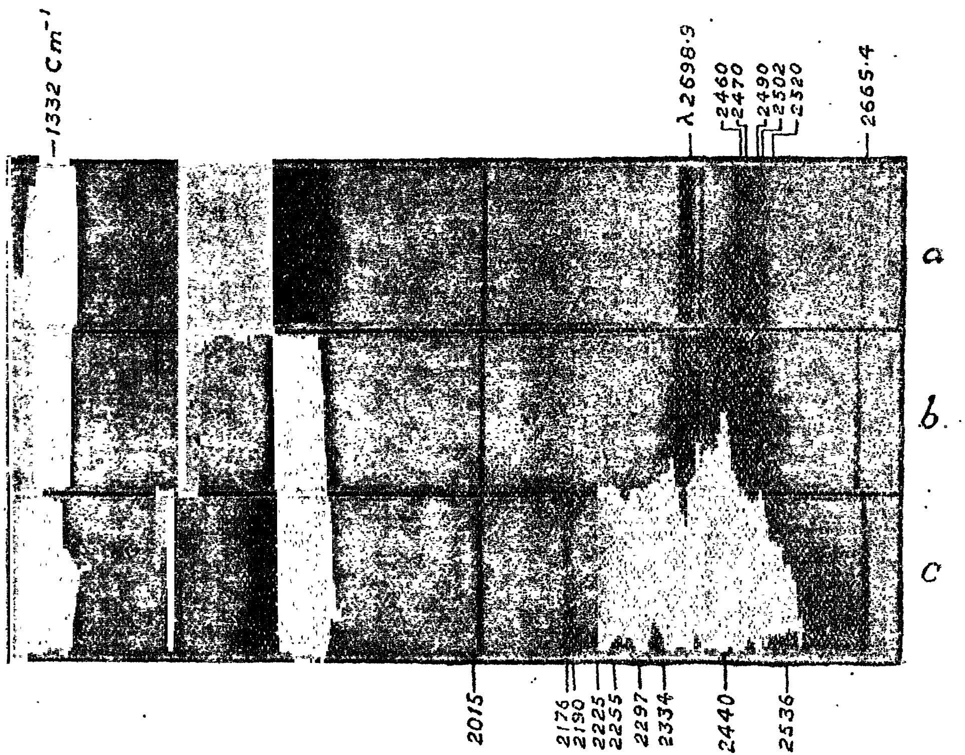

Fig. 2. The Second-order Raman spectrum of diamond taken with the large quartz spectrograph. Enlarged from different negatives with different exposures.

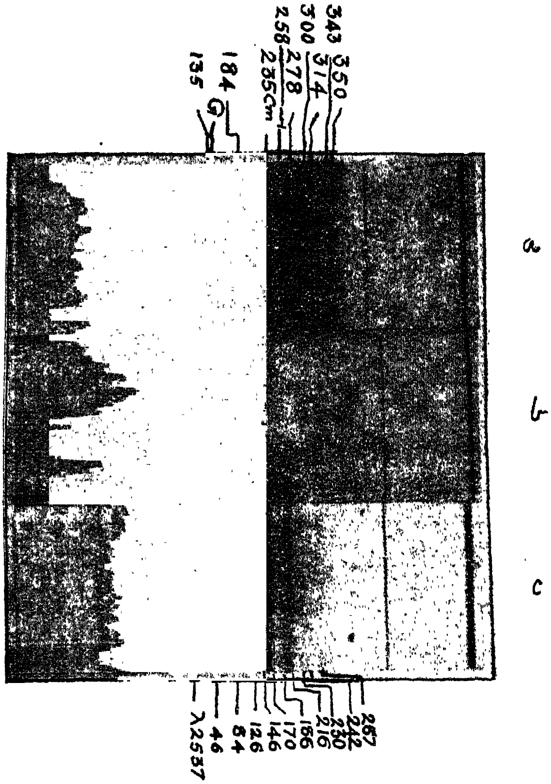

Fig. 3. (a) Raman spectrum of rocksalt taken with the large quartz spectrograph.

(b) Raman spectrum of potassium bromide taken with the same instrument.

(c) Raman spectrum of potassium bromide taken with the medium quartz spectrograph and enlarged to the same extent.

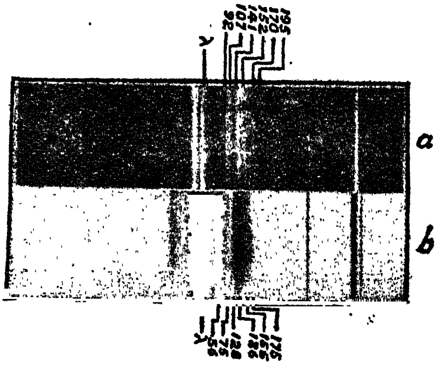

Fig. 4. (a) The lattice spectrum of NH_4Cl at 268°T

(b) The lattice spectrum of NH_4Br at 300°T

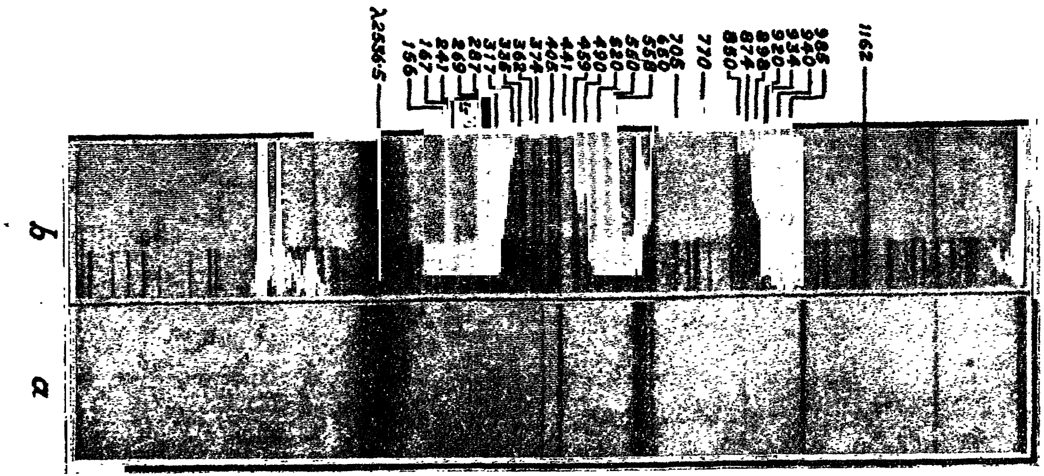

Fig. 5. (a) Mercury spectrum taken with the medium quartz spetrogragh.
(b) Raman spectrum of topaz taken with the same instrument.

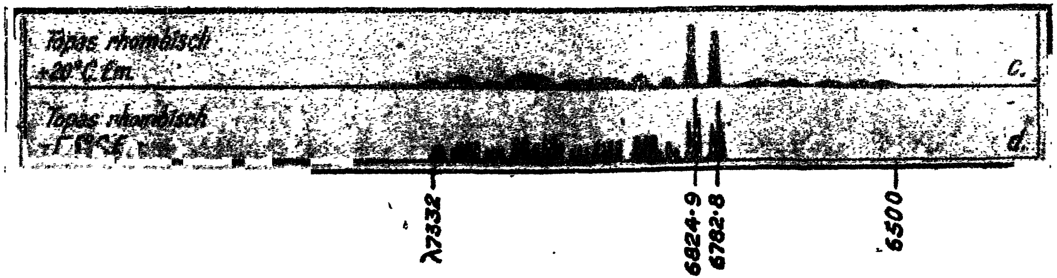

Fig. 6. Chart showing the luminescence spectrum of topaz taken from Deutschbein's paper.

Printed by Kalipada Mukherjee at Eka Press, Baranagore, Calcutta.

36TH INDIAN SCIENCE CONGRESS, ALLAHABAD, 1949

SECTION OF CHEMISTRY

President :—Dr. P. B. Ganguly, D.Sc., F.N.I.

Presidential Address

COLLOIDS IN BIOLOGY AND MEDICINE

It is my first duty to offer you my sincere thanks for the honour you have done me by asking me to preside at the Chemistry section of the Indian Science Congress. I deeply appreciate your kindness, particularly because this honour has been granted to me while the session is being held at the seat of my own *Alma Mater*, where I had the privilege of learning my first lessons in chemical research at the feet of Professor N. R. Dhar. I am conscious of my limitations, which are best known here, but I hope with your kind co-operation, I shall be able to discharge my duties successfully.

In my address I propose to deal with certain aspects of Colloid Chemistry with special reference to biological processes. Though the early advancement of colloid chemistry was mostly due to the endeavours of chemists and physicists, the trend of recent work clearly indicates that the future development of Colloids will be mainly in its application to living matter and life processes. A salient feature of colloids is that they offer a fruitful meeting ground for the different branches of science. Its manifold applications not only to industry, but to biology and medicine have made it of vital importanc to the physiologist and the biologist. Colloid technique, which is primarily suited for the study of sub-microns and minute particles, offers powerful tools to probe into the nature of isolated growing cells and tissues and leads to a better understanding of the types, the mechanism of sub-division, their movements and the factors affecting the nutrition of cells, muscle, and blood. An instance in point will be the study of protoplasm.[1] A purely biological approach to its study will be hopelessly inadequate. Protoplasm has been defined as the material basis of life and it is only when the knowledge of the biologist on its behaviour, the results of the chemist regarding its constitution, the investigation of the Colloid Chemist on the state of dispersion and aggregation of its constituents and the experience of the physicist regarding the structure and energy propagation in an essentially dynamic system are all woven together that a fabric giving a comprehensive picture can be obtained.[2]

About 35 chemical substances have been found in living matter. They consist primarily of salts, sugars, higher carbohydrates, fats, lipoids and proteins. The salts and sugars are mainly in true solution, but the fats are colloidally dispersed as emulsions. The proteins exist as solutions, gels and coagula. Protoplasm is composed of about 75% water. The approximate composition of the remaining dry solid is 50% protein, 20% fats, 20% salts and 10% carbohydrates. The protoplasmic substance appears homogeneous under direct illumination, but viewed under a dark field ultra-microscope, it shows itself as a fine emulsion consisting of two phases, cryptoplasm, which is optically empty and phaneroplasm, which is constituted of visible emulsion globules.[3] In general the system is polydispersoid of which the proteins are the most basic and vital constituents and largely determine the characteristic properties of the protoplasm. The system is a dynamic organisation and multiple simultaneous chemical changes are constantly in progress in which not only the constituents but osmotic effects play their part. Though usually fluid, protoplasm possesses great elasticity and undergoes marked viscosity changes from a perfectly fluid condition to that of a firm jelly. The viscosity changes are linked up with varying stages of coagulation of colloidal matter and have great physiological significance. Variation in fluidity is dependent on temperature, presence of electrolytes, etc., but characteristic changes occur during reproduction, growth, injury and disease.

According to Pauli, proteins display those properties which in their totality represent life. Ample evidence exists to regard protein as the fundamental substance which underlies all living processes. Salts, carbohydrates and fats will keep the living machines going, but to make a new protoplasm a protein base is necessary. Protein and protoplasm have much in common in their colloidal behaviour ; they coagulate, swell by imbibition, are elastic when liquid and are capable of a large variety of structural configuration. Electro-kinetic experiments on suspensions of living cells have shown that the sign and magnitude of the charge on cells are determined by the chemical nature of the outer enveloping layer, which in the case of most animal cells is to a large extent constituted of protein. Iso-electric point, which is a characteristic property of proteins is of primary importance and the sign and magnitude of the charge on emulsion of cells is controlled by the pH of the medium in which the cells are suspended.

There is a pronounced endeavour in protoplasm to save its identity : an attempt at self-preservation. It has a remarkable capacity to form a new surface to repair a torn part. When a dividing cell is punctured, the mitotoic figure temporarily collapses but if the collapse be not too drastic, the cell reorganises itself. It is considered that during cell division, the protoplasm passes through a series of rapid viscosity changes, which at one stage attain a maximum value. The viscosity changes are probably due to a temporary coagulation of some protoplasmic constituent, followed by its regeneration of colloidal state. This behaviour is linked with the nature of the effects produced during anesthesia. In dilute concentration, ether makes the protoplasm more fluid and stops division, but at higher concentration it causes coagulation.[4] It is considered that anesthesia in life processes is due to a variation of colloidal balance of the system. If one could draw an analogy, this behaviour is similar to that of a thixotropic gel. Thixotropy is considered to be intimately connected with the recouperative capacity of a punctured protoplasmic cell and with anesthesia.

The protoplasm is capable of a variety of structure. The proteins in living matter, and protoplasm are generally fibrous in structure. The visible structure of the protoplasm is partly a fine suspension and partly a jelly, some times the structure is cellular. The emulsion globules are symmetrically arranged with an angular orientation and in cross-section resemble a honeycomb. Dujardin has described protoplasm as a living jelly, and thus the colloidal experiences of emulsions and of a gel system figure largely in the life history of a protoplasm.

It is not intended to give any detailed account of the protoplasm as that would mean a stupendous task. A brief survey of certain phases in the properties of the protoplasm has been given mainly to emphasise the colloidal aspects. It must be remembered that living cell is dynamic and for its nutrition it is regularly and continuously undergoing a series of chemical changes. In the complete organism, colloidal constituents are only a part and are functioning in the simultaneous presence of water, salts, sugar, fats and other substances, which have their functions as important as those of the protein emulsions. The problem of the protoplasm is indeed as intricate in its complexity as it is fascinating in its action. Undoubtedly colloid physics has an important future in this field of study.

Frequent attempts have been made to imitate the living cell in the laboratory and to impart mobility to it. Many of the forms and structures met with in living cells, embryos, tissues, plants and leaves have been artificially produced. Leduc[5] was able to synthesise shell like growths by adding crystals of calcium, iron, manganese salts, etc., in solutions of trisodium phosphate. Crystallisation of calcium salts in a colliodal medium gave a structure very similar to growth of leaves in plants ; slow diffusion of calcium chloride into solutions of sodium silicate containing various salts, produced artificial structures possessed of mobility.[6] Though mobility and structure are not the only qualities of a living cell, the similarity in form growths is indeed remarkable. Consideration of the conditions under which these formations materialise may, therefore, be of interest. Most of the inorganic substances used to stimulate the living tissues are formed in a gelatinous state, though ordinarily they precipitate in crystalline or granular forms. In all these laboratory imitations, diffusion, osmotic effects, the presence of a gel medium and the generation of a colloid system appear to be important controlling factors. No doubt the same factors are operative in the broader field of reactions in gels.

Chemical reactions in gels have been the subject of a great deal of investigation. While engaged in the artificial production of animal muscles, Liesegang[7] made an observation in which precipitation occurred in discontinuous stratified layers. The phenomenon was so strange and differed so much from ordinary behaviour of chemical reactions, that it soon attracted a great deal of attention. Nature abounds in stratified structures both in the living and the inanimate world. In the early stages Liesegang explained the formation of banded agates, and of malachite as due to a process of diffusion of reacting substances followed by stratification in gelatinous silica. He advanced similar explanations for various banded geological samples. Traube[8] was able to produce structures similar to protoplasm, agate and other geological minerals by the diffusion of ferric chloride into set plaster containing potassium ferrocyanide. Watanabe[9] produced periodic precipitates of metallic sulphides and stressed their similarity with many geological specimens. There are also numerous points of similarity between Liesegang structures and physiological growths. Liesegang drew attention to many analogies between the phenomenon and the arrangement of fibres in bones. Gall stones, urinary calculi and various pathological concretions have stratified structures. A remarkable stratification is seen in many shells and in the mother-of-pearl. Periodicity has also been observed during bacterial culture. Lüger[10] found sterile zones on the addition of volatile disinfectants on bacterial plates and Bhatnagar[11] observed periodicity during germ culture in gelatine. Periodicity in biological and botanical structures is a fairly frequent occurrence, but all instances need not be considered as Liesegang phenomenon. Periodicity can also be produced in totally different circumstances by external causes like temperature changes, climatic conditions, diurnal variations and changes in environments.[12]

Liesegang rings are generally formed by the diffusion of two reacting solutions in a suitable gel medium. The experimental conditions have been numerously varied and banded structures have been obtained on glass plates, tubes, U tubes, in capillary tubes and in the capillary space between two glass plates. There are numerous instances where substances which refuse to stratify under a given set of conditions produce periodic structures by a change of gel, variation of concentration, and alteration of other cxperimental conditions. If an experimenter be prepared to persevere, it would perhaps be difficult for him not to get a stratified structure. The concentration of the reacting solutions, the nature and concentration of the gel, pH in silica gel formations and the presence of hydrolysed products in gelatind all influence the nature of the stratifications, but a large variation in these factors appears permissible. A characteristic behaviour shown by most Liesegang structuctures is that the distance between successsve bands increases as one moves away from the center of difiusion. Schleussner[13] considers that the distance from origin of successive rings forms a geometrical series. Various other attempts have been made to express the distance by mathematical formulation, but the structures are generally too variable for any precise treatment.

Periodic structures are generally produced in a suitable gel medium, but the presence of a gel is not indispensable. Numerous investigations have been carried out where stratified precipitates have been formed by the usual reactions in the complete absence of any gel medium. The first production of periodic structures without any gel, must be attributed to Runuge[14] who published a collection of striking photographs of rhythmic structures, on blotting paper. Lenk and Brach,[15] Watanabe[16] and later Davies[17] repeated these experiments on filter paper, cotton cloth and unglazed porcelain Morse and Pierce[18] and later Dreaper,[19] grew Liesegang rings in capillary tubes. Tilmans and Heublin[20] obtained rings in sand, Holmes[21] used flowers of sulphur and Sekera[22] found finely powdered kieselguhr as a remarkably good medium. Periodic structures between two glass surfaces in the absence of a gel have been grown by E. J. Mills[23] and by Notboom,[24] whose preparations were remarkable for their regularity of formation. Brodersen[25] investigated the effect of dimensions of the capillary space on the nature of the structure. Ghosh,[26] working in the Patna laboratory, carried out a detailed study of the formation of periodic structures in the capillary space between glass plates and marked their development under the microscope He observed that the precipitates at the early stages of their formation were colloidal and showed distinct Brownian movement. Periodic structures have also been grown in liquid or semi-fluid substances. Lord Rayleigh[27] has described a fine struetured rhythmic preparation in the presence of sugar solution; Fuchtbauer[28] obtained a periodic separation of chloroform in a solution of chloral hydrate, and Moeller[29] and later Schroeder[30] grew rings in wheat kernels. Herrera obtained fine cellular lines in porous vessels, and Endell[31] obtained structures in fused silica. Various other instances could be given but enough examples have been cited to show the variety of circumstances under which banded structures develop. It is abundantly clear that a gel medium is not indispensable.

A number of periodic structures have been produced in which diffusion plays the primary role. Vanzetti[32] claims to have obtained periodic coloured layers in water by simple diffusion processes. Distilled water was tinted with slightly reddened phenolphthalein and a concentrated solution of zinc chloride allowed to diffuse from the bottom. The discharge of colour was discontinuous. Koenig[33] obtained a well-separated periodic precipitation of ammonium chloride by allowing gaseous ammonia and gaseous hydrochloric acid to diffuse from the two ends of a long narrow tube. Similar observations were made by Enoch Karrer[34] working with aqueous solutions. Williams & Mackenzie[35] also studied ring formation in gaseous mixtures.

Whatever may be the theoretical explanations for the Liesegang structures, there can be no doubt that diffusion processes play a very important role in their formation. An attempt has been made to calculate the concentrations of the reacting substances at different layers of the gel[36]. The system considered was a gelatine gel containing potassium chromate with silver nitrate diffusing from the top. The concentrations of the silver nitrate in different layers of the gel were calculated with the help of an equation based on Fick's law, *viz.*,

$$V = C\left\{1 - \vartheta\left(\frac{x}{2\sqrt{DT}}\right)\right\}$$

The layer concentrations of the potassium chromate were obtained from the following equation derived by solving the diffusion equation under the conditions germane to the experiment and evaluating the costants as in a Fourier's series :—

$$V = \left\{\sum \frac{2A}{m\pi}\, e^{\frac{-D_1 m^2 \pi^2 t}{l^2}} \sin\frac{m\pi x}{l} + \frac{A}{l}x\right\} - aC\left\{1 - \vartheta\left(\frac{x}{2\sqrt{DT}}\right)\right\}$$

So far as this particular system was concerned, the calculated values for concentrations were very useful in determining the conditions at which silver chromate formed a colloidal system.

A very large number of theories have been advanced to explain the Liesegang phenomenon. Unfortunately too often theories have been based on observations of a few isolated systems and have, therefore, failed to explain the large number of experimental peculiarities observed in this field.

The supersaturation theory of Wilhelm Ostwald,[37] the adsorption theory of Bradford,[38] the diffusion wave theory of Wolfgang Ostwald[39] and the colloid adsorption theory of Dhar and Chatterji,[40] are well known. According to Hedges,[41] each one of the theories is right in its own specific approach to the problem, but under certain experimental conditions any one of them may be invalid. For a more comprehensive application, a fusion of some of the basic ideas of the different theories may be useful.

As has been stated before, Liesegang at the very beginning pointed out the connection between periodic precipitation and the layer structure of certain pathological growths. Colloidal matter is present in abundance in the tissues and body fluids of animals. Under diseased conditions, the colloid balance is upset and pushed beyond peptisation limits when precipitation begins to occur. According to Liesegang, precipitation is delayed by a process of supersaturation and adsorption of colloidal matter. Precipitation alone, however, will not explain the formation of a compact stone as fine gravel will ordinarily be eliminated by excretion. A comprehensive explanation on a colloid-chemical basis is available from the work of Schade[42]. Cholesterol is held in solution in bile up to a high concentration by the simultaneous presence of cholates. During inflammatory conditions or prolonged stasis of the bile, proteins, fats and calcium bilirubinate separate. These bring about a deposition of cholesterol, which instead of forming a granular precipitate, forms small droplets, which gradually grow and acquire a more or less spherical shape. The important point is that ordinary gall stone forms as a mass of cholesterol and of cholesterol and calcium bilirubinate as a colloidal mass in the first stage. A process of gelation induced by albuminous matter produced by inflammation, rather than of granular precipitation, appears to lie at the basis of stone formation. In some cases calcium bilirubinate separates with the albumin which together form nuclei for the gelation of cholesterol. In time, the cholesterol and calcium salt of bile gradually transform to a crystalline form by a process which is analogous to crystallisation in a gel and thus concentric deposition and striations, which are characteristic of reactions in gel may be produced. This affords a broad basis for layer structure of gall stones from known colloidal behaviour.

The shells of many aquatic animals consist of concrement structures. A feature of these formations is that they often consist of deposits of both colloidal and crystalloidal matter. The most interesting example is offered by the mother-of-pearl. The pearl itself consists of fine and regular striations and is one of the most interesting examples of growth in the animal body. Chemical analysis shows that the pearl consists of calcium carbonate, water and organic matter.

G. & H. Harley[43] gave the following analysis for the pearl and the mother-of-pearl :—

	Pearl	*Mother-of-pearl*
Calcium Carbonate	91.7%	66.0%
Organic matter	5.9%	2.5%
Water	2.2%	31.0%

It would thus appear that the components of both the pearl and the mother-of-pearl are identical though they vary in proportion. The calcium carbonate is usually in the form of aragonite and the organic substance is conchiolin, an insoluble protein matter.

Strangely enough the production of the pearl is an accident, and is more an effect of disease in the oyster, rather than any normal growth. For its supply of food, the oyster constantly pumps water through its ciliated fins, retaining the choice bits of larva and small insects for its consumption. A troublesome grain of sand or a malignant parasitic insect, now and then, succeeds in dodging through the celia and gets stuck under the shell of the oyster. These foreign bodies cause an irritation, as a result of which the oyster secretes the nacreous fluid, which entraps calcium from sea water and gradually deposits a layer round the foreign body. Irritation continues and layer after layer is deposited and gradually a full grown pearl develops.

It is interesting to observe that the ancient Chinese method of producing artificially cultured pearls is essentially the same as the natural process. The oyster is fished out and a small pellet of mud or a tiny image of Buddha is introduced under its shell by skilled hands. The oyster is returned to the sea and in due time is fished out again to deliver a pearl. A number of beautiful pearl images of Buddha prepared by this process, can be seen at the British Museum in London. The Chinese method was developed on scientific lines by Japanese investigators. It was found that the most vital part of the oyster for pearl formation was the outer epithelial layer surrounding the mantle. The epithelium secretes from outside the nacreous material of the pearl and thus not only the foreign matter, but the living epithelial cells play a vital part in the process. It is however, considered that the presence of an irritating nucleus does not represent the essential mechanism of pearl formation. Hardman, who made a detailed study of Ceylon pearl fisheries, gave the theory that pearl formation was caused by larva of cestode or tape-worm. The presence of a parasite, however, is not considered necessary and Hardman's theory has been given up. Pearls may also be formed due to pathological conditions in the mollusc in much the same way as in the formation of stones in other animals.

As early as 1814, Brewster[44] explained the iridescent colours of mother-of-pearl as due to two factors—a grating effect on the surface and an interference effect caused by a thin film of calcium carbonate. The grating effect on mother-of-pearl can be easily transferred to a film of gelatine dried on its surface and the distance between the lines can be measured. Lord Rayleigh[45] considers that the colour effect of the pearl is not due to a single film but is caused by alternate layers of calcium carbonate and conchiolin forming a series of thin parallel plates. This alternate deposition of a mineral matter is exactly similar to well known cases of periodic precipitation. In fact on the synthetic side several attempts have been made to reproduce the structure of the pearl.

In 1913, Liesegang[46] produced iridescent layers of calcium phosphate by the diffusion of trisodium phosphate in a gelatine gel containing calcium nitrate. Leduc reproduced the structures and obtained fine lines, about a thousand per millimeter, by using concentrated trisodium phosphate. Clement and Riviere[47] also produced iridescent structures by a similar process. In all these experiments, the periodic precipitate consisted of calcium phosphate. An examination of the chemical analysis of the pearl, however, shows that it contains no phosphate and the mineral matter is entirely calcium carbonate. It was, therefore, considered that the nearest approach to the natural formation would be secured, only if calcium carbonate could be stratified to give fine layers of a dimension comparable with that of a diffraction grating. This was done by allowing a solution of calcium bi-carbonate in gelatine to set to a gel and deposit calcium carbonate by slow decomposition. A beautifully iridescent preparation was obtained which exhibited the colours of the mother-of-pearl.[48] On examination under the microscope a series of regular and more or less parallel lines could be seen, with a spacing of about 4000—6000 per cm. Incidentally, during these experiments, the presence in the gelatine of a proportion of gelatoses was found to be necessary. These elements could be considered as the nearest approach to the natural mother-of-pearl, but the organic matter in these cases was gelatine instead of conchiolin. Unfortunately conchiolin is a highly insoluble substance and thus difficult to obtain in a workable condition.

Many other formations[49] in the animal body are known which are striated. "Stones of the pancreas and of salivary glands, prostatic stones, lime concrements in old softened tissues, rice bodies of the joints, thrombi of the blood and brain sand[50]," show more or less allied structure as the biliary stones. Natural processes are no doubt complex being influenced by many other concomitant factors and a gelatine gel is not quite the same as body colloids. It must, however, be admitted that the same physico-chemical considerations, which apply to reactions in gels, are to a large measure applicable for the mechanism of various malignant growths in the animal.

Radiations of a suitable wave length have often been noticed to have a marked influence on the formation of Liesegang and allied structures, but the results do not permit of any generalised conclusions. During the production of bands of colloidal gold in silicic acid gels, Davies[51] observed that irradiation helped stratification. Similar effects were recorded by Tryhorn and Blacktin[52], who found increased precipitation on exposure. Hatschek[53] observed anomalous band formation on irradiation of the growing structures. Scott Blair[54] recorded a difference in the behaviour of visible and of ultra-violet light. The application of X-rays and of radium rays have also been tried, but no marked effect could be observed.

Morison[55] passed a beam of light through kaolin suspension contained in a rectangular tank and found that exposure to light caused a distinct stratification of the particles in layers. It is evident that these effects are connected with photophoresis. Schaume has shown that silver sols show a definite migration in the direction of light and the colloid particles get deposited on points on which the light beam is focussed. It is possible that the radiation pressure of light also plays a part.

Depending on the nature of the system and the wave length of irradiation, light can both synthesise and coagulate colloidal solutions. Not only ultra-violet light, but radiations of all types have their influence on the size of colloidal particles. Heat coagulates colloids. Tropical sunlight has been found to be capable of flocculating several colliodal solutions[56] and α-rays, β-rays and X-rays all influence the nature of colloids.

In a few cases light has been found to possess a stabilising effect. Nordenson[57] studied the effect of ultra violet light on metals suspended in water. Instead of coagulation he observed disintegration, which he ascribed to the formation of hydrogen peroxide by rays on aqueous medium of the hydrogels. Galecki[58] also utilised the formation of hydrogen peroxide to explain the behaviour of silver hydrosols on irradiation. In this case the colloidal particles were destroyed ; there was an increase in conductivity and a decrease in viscosity. It is considered that the hydrogen peroxide dissolves the colloidal silver and forms silver ions. Explanations like these raise a fundamental question : Is the effect of radiations on colloid mostly dependent on photochemical changes, or is it due to photoelectric and physical effects ?

The more general effect of irradiation of colloids is coagulation. Most metal, metallic sulphide, oxide and hydroxide sols are coagulated by light. The cataphoretic velocity, charge, conductivity, pH, viscosity and other physical properties are considerably altered on exposure. A point of great significance is that both positively and negatively charged colloids are equally affected by light. According to Nordenson[59] the coagulating effect of ultra violet light on gold sols was not due to any photo-electric effect, as the result was the same irrespective of the fact whether the colloid was positively or negatively charged. The observations of Doelter, Spear[60], Young[61], Rene Audubert[62], Mrs. Dhar[63], Lal[64] and many others have clearly shown that coagulation by visible and ultra violet light is not limited to sols of any particular sign of charge. The effect of β-rays on colloids has been extensively studied. As will be seen from the following table[65],

The effect of β-rays on the coagulation of colloids

Nature of the colloid	*Charge on the colloid*	*Source of β-rays*	*Observations*	*Author*
Alkaline blood globulin.	Negative	$RaBr_2$	Coagulation	Hardy
Acidified blood globulin.	Positive	$RaBr_2$	No coagulation	Hardy.
Ferric hydroxide	Positive	0.1 gm. $RaBr_2$	No coagulation	Henri & Meyer.
Silver sol ..	Negative	0.1 gm. $RaBr_2$	No coagulation	Henri & Meyer.
Manganese, iron chromium and aluminium hydroxide sols.	Positive	0.5 gm. $RaCl_2$	No coagulation	Doelter.
Ferric hydroxide	Positive	..	Very slow coagulation.	Righi.
Silver sol ..	Negative	0.015 gm. $RaBr_2$	No coagulation	Jorrissen & Woudstra.
ChromiumHydroxide sol.	Positive	0.015 gm. $RaBr_2$	Less stable towards electrolytes.	Jorrissen & Woudstra.

generally positively charged sols were found to be less sensitive, which is contrary to expectations, in presence of electrons of high penetrating power, X-ray radiations on colloids, however, give evidence in favour of coagulation by a charge neutralisation process. Crowther[66] found positively charged sols invariably coagulated but negatively charged sols were mostly unaffected. Some exceptions to this behaviour have, however, been observed. It would appear, therefore, that although no direct and pronounced relationship might be apparent between the sign of the charge of the colloid and the charge of the rays, photo-electric effects cannot be altogether eliminated. Further experiments are necessary for a more definite conclusion.

Another view point with regard to the mechanism of coagulation by radiations is an entirely photochemical one. Schaum[67] held the view that the action of light is not a physical process, but depends on chemical changes of either the dispersion medium or of traces of electrolytes present in the colloid system. Stintzing[68] held similar views. Lal[69] studied the coagulation by light of both positively and negatively charged sols and observed distinct pH. variations in most cases. Coagulation was explained as due to the photochemical decomposition of the stabilising substances. Sinha[70] found similar evidence from studies of emulsions. Emulsions coagulated on exposure and showed an increase of pH indicating a dissociation of the emulsifying agent. Heller[71] observed an increase in particle size on illumination of a dialysed ferric hydroxide sol. Although he explained the effect from changes on the double layer, his sol being prepared from hydrolysis of ferric nitrate, the photochemical decomposition of nitric acid even in the dialysed sol can not be entirely neglected. The observation would thus be capable of explanation on the basis of photodecomposition of the stabilising complex. The effect of light on the size of gold particles has been the subject of numerous investigations, but the results are not always clearly understood. Beaver and Muller[72] observed that gold sols prepared by reduction with hydrazine, phosphorus, formaldehyde or acetylene did not change on exposure to mercury lamp, whereas sols prepared with hydrogen peroxide, tannin, quinol,. catechol, resorcinol, and pyrogallol displayed slow coagulating effect of lighty Most of the latter reducing agents undergo photolysis and thus Lal's theory appears to be applicable to these cases. Banerji[73] has also found that only those gold sols, which are produced by reduction with an easily photodecomposable substance, show coagulation under light. All cases however do not conform to this rule, tannic acid gold sols behaving in a different manner. Photochemical reactions of the stabilising substances, is certainly a very important factor, which disrupts the double layer on the surface of the colloid particle and reduces its charge. It has, however, to be admitted that in some cases of coagulation by light, secondary effects may come into play.

The behaviour of colloids towards light is linked with several branches of actino-therapy, particularly in relation to deficiency and matabolic diseases. The main ingredients of most biochemical compounds are proteins, carbohydrates, salts and fats. Proteins which possess high molecular weights and characteristic iso-electric points, undergo marked changes in their colloidal behaviour on irradiation. The effect of irradiation in many cases is similar to changes brought about by increased temperature. It is well known that calcium salts when administered directly are not easily assimilated in the body, but the presence of certain vitamins greatly accelerates the assimilation in the system. Vitamins are synthesised by light, which clearly shows the photochemical basis for the beneficial effects of rays in increasing body metabolism. A photochemical basis is discernible throughout in the behaviour of proteins on exposure. Gelatine solutions exposed to light show an increased conductivity, lose their power of swelling and undergo alteration in their action as a peptising agent. Albumin has frequently been subjected to the action of ultra violet light. Flocculation with changes in pH, viscosity, surface tension and peptising properties have been observed. The formation of new chemical entities is often postulated. It is considered that slightly acidified gelatine gives ammonia, albumin produces aldehydes and globuline produces a substance probably proteose in nature. In spite of a plethora of data, the precise nature of the changes, however, are not always clear. The emphasis on this branch of study has, however, been more on the physiological aspects and colloid aspects have been relegated to the background.

Adsorption offers another point of contact between colloid phenomena and biological processes. The view is held that the mechanism of reactions on cell surfaces is similar to the oxidation of amino-acids on blood charcoal with iron acting as catalyst. The quantity of amino-acid oxidised is dependent on the quantity adsorbed and is diminished by the addition of capillary active substances which diminish adsorption. The experiments of Warburg[74] showed that many organic substances like amino acids, etc, are oxidised by oxygen in presence of blood charcoal acting as a catalyst. Freundlich has shown that the rates of the reactions are connected with the adsorption isotherms of the organic substances on the active charcoal surface. Dhar and co-workers have made detailed study of catalysed oxidation and its relation to metabolism. The body tissues are full of capillaries and thus there is an abundance of surface in the system. It is considered that oxidation process in the body proceeds catalytically on surfaces, where adsorption plays a fundamental role. The reactions between antigen and antibody in serology, the development of toxic bodies in bacterial culture, the accumulation of heart stimulants in the colloids of the heart in accordance with Freundlich's adsorption equation and the direct use of adsorbents like charcoal, and silica preparations in therapeutics, are a few of the instances among many others where surface activity and adsorption play an important role.

The enzymes show all the properties of hydrophillic colloid. The catalytic activities of enzymes are greatly dependent on adsorption processes. The separation and purification of enzymes depend to a large extent on their specific adsorption. Some are preferentially adsorbed by alumina, others by kaolin, while some are adsorbed by both, depending on the pH of the medium. The velocity of a catalysed reaction varies exponentially with coneentration in agreement with the adsorption isotherm. Langmuir[75] has discussed the application of Schutz's rule to the rate of the reaction. He interprets Schutz's rule to indicate that the velocity of the reaction is proportional to the amount of the enzyme and varies inversely as the concentration of the products of the reaction. Langmuir explains the catalytic activity of enzymes on the basis of the formation of a monomolecular film which may be considered to have a definite orientation. The enzymes are remarkably specific in their action ; a definite enzyme is suitable for a particular biological reaction. The specific action of enzymes is explainable on the basis of definite orientaion of the adsorbed molecules on their surfaces. It is remarkable how this behaviour is similar to the adsorption of many organic compounds on silica gel.

Gyani[76] definitely established the formation of oriented adsorption films in the course of his investigations of the adsorption of organic substances on silica gel. It is proposed to give a short review of this work in view of the many points of similarity between adsorption on inorganic gels and the mechanism of catalytic activity of biocatalysts.

Gyani measured the adsorption of a large number of monobasic, dibasic, hydroxy and halogen substituted fatty acids and also a number of aromatic acids on silica gel. In the case of monobasic fatty acids, the number of moles adsorbed is practically the same for all members of the series from acetic to stearic. This result has been interpreted as indicating a definite orientation of the adsorbed molecule, such that it stands up in a vertical pile with the polar carboxyl group as the base. The experimental data obtained with dibasic acids are amenable to a quantitative relation which leads to the suggestion that the molecules in this series are oriented so as to lie flat on the surface. The orientation in the adsorbed layers is similar to orientation of molecules in unimolecular films on liquids at low compression.

In another series of experiments measurements were made with vapours of paraffin hydrocarbons, benzene, toluene, o. & m. xylenes, cyclohexane, alcohols, esters and ketones[77]. Orientation in the adsorbed layers was again observed in most of these cases. In the case of aromatic hydrocarbons the orientation is such that the molecules lie on their edges with the plane of the ring perpendicular tothe surface. The case of cyclohexane was interesting, in as much as the orientation of the surface film varied with variations of pressure. At low pressure, the orientation is similar to that of the paraffins but at about 1/5th the saturation pressure the nature of the film changes and molecules orient in a manner similar to the aromatic hydrocarbons. Silica gel has a characteristic capillary structure and is composed of a large number of micro-vessels of fixed volume. For adsorption in such systems a capillary condensation theory was first put forward by Zsigmondy and later developed by Patrick. In the present experiments it was observed that at saturation pressures the data conformed to the capillary condensation theory, but at lower pressures adsorption occurred with the formation of monolayers rather than as a process of bulk condensation Both the capillary interspaces and the micelle play their part in the adsorption process, but at low pressure the latter predominates.

From the results reported above it is abundantly clear that adsorbed molecules are oriented in a characteristic manner. There can be no doubt that the pattern of orientation is an important factor in heterogeneous catalysis and it appears reasonable to think that a similar mechanism is operative in reaction on surface of enzymes.

The gel used in the experiments of Gyani was prepared in the laboratory. Ray [8] has investigated the formation of silica gel from alkali silicate solutions and has worked out the optimum conditions for the formation of the gel. Temperature and pH appear to be important. It is well known that the absorptive capacity of silica gels vary according to the conditions under which they are prepared Gyani's gels were, therefore, tested and gave practically the same adsorption as Patrick's gel. Incidentally reference might be made to a method of manufacture of silica gel from silicate minerals. Wolochow[79] prepared active silica from the mineral serpentine, by treatment with acids, whereby the magnesium could be removed as a soluble salt, leaving a porous silica gel. After a slight initial heating, action continues from its own heat of reaction. It may be profitable to examine the possibility of utilising indigenous minerals for the manufacture of the gel, which has so many important applications in industry.

The adsorption of a number of alkaloids displayed some points of physiological interest. Morphine, nicotine, quinine, quinidine, cinchonidine, brucine, strychnine and piperine were adsorbed on silica gel and the amounts measured[76]. The adsorption isotherms of brucine and strychnine ran parallel and close to one another. The cinchona alkaloids gave nearly equal adsorption, while piperine had no positive adsorption.

Two points of interest emerge out of these experiments. There appears a distnct connection between adsorption and constitution of molecules and further the adsorption of toxic substances was higher than that of non-poisonous ones. Brucine and strychnine are similar in constitution and differ from one another in respect of two methoxy groups only. Their adsorptions are comparable. The adsorption isotherms of cinchonidine, quinidine, and quinine form a cluster. These results suggest that compounds allied in constitution have similar adsorption. If the alkaloids studied be arranged in order of their adsorption, strychnine, brucine and nicotine are adsorbed the most. Morphine has shown a somewhat lesser adsorption. It is interesting to note that the pharmacopoeic dose for morphine is between 6 to 30 milligrams whilst that of strychinie is only 1.4 milligramme. Piperine which has no positive adsorption is non-toxic. There is thus an indication that alkaloids which act physiologically as powerful poisons are adsorbed most. The point, however, should not be stretched too far, as adsorption is not the only factor.

A laboratory technique which is essentially dependent on adsorption the method of chromatographic analysis, which has proved very valuable in separating many medicinal plant products. The method first used by the Russian botanist, Tswett, after a lapse of time, was rapidly developed and has now become an established laboratory process[80]. The method primarily depends on the difference in adsorptive power of various substances and their tendency to de-adsorb on washing with suitable solvents[81]. The importance of the technique lies in the fact that it can be used for separation of substances which are very much similar in constitution, and can be used when substances are available in small quantities. In the earlier experiments Brockmann's aluminium hydroxide was used, but later a variety of adsorbents like hydrated magnesium silicate, varieties of clay, activated lactose etc. have been pressed into use. In the case of colourless ingredients, colour is developed by Zechmeister's process of painting the column with a reagent capable of developing a coloured compound with the adsorbed substances[82].

Chromatography has been extended to the partition of the solute between two liquid solvents forming separate layers in a column of silica gel. The method has been largely employed in the study of amino-acids from protein hydrolysis, and in the separation and purification of many plant products[83].

Peptisation and flocculation are essential properties of colloidal systems. These principles find their applications in the diagnosis of certain diseases and the pathological examination of body fluids. The peptising power of a protective colloid is usually represented by its gold number. The gold number values of the spinal fluid are useful in the diagnosis of meningitis and brain infection. Flocculation reactions are used for the testing of blood serum and have given a method of great practical utility in the diagnosis of diseases. Colloid technique is widely applicable in the testing of other body fluids like gastric juice, bile, urine, etc. Thus, medicine in all its aspects has made free use of colloid chemical methods.

It has been found advantageous to use many medicines in a colloidal form rather than as ionogenic salts. Such a method of administration of a medicine secures a low osmotic activity and a large surface. At present a large number of colloidal solutions are in therapeutic use and new preparations are being added. The commonly used colloidal preparations are those of metals like calcium, iron, manganese, silver and of non-metals like iodine, sulphur, etc. Sometimes the colloidal preparations are mixed with vitamins. In fact the method of using medicines in a finely sub-divided state is coming more and more into practice.

It is a matter of some historical interest to refer to the process of internal use of metallic preparations in the Indian Ayurvedic system. Oxides and sulphides of metals were directed to be triturated with honey in a granite mortar till the development of a particular shade of colour. This procedure was no doubt an attempt to reduce the substance to a finely subdivided state, which in current terminology will be described as a colloidal condition. Evidently this empirical procedure secured what the modern methods have perfected.

There are many other spheres of biological activity where colloids play an important part[84]. Again and again we find predominant colloidal characteristics like electric charge, katophoretic migration, iso-electric point, coagulation, peptisation, adsorption, membrane permeability and many others, playing a fundamental role in most vital processes. Life is a continuance of the colloidal state and coagulation means death. As cytology marches onwards, many a chapter of the interplay of colloid behaviour and life processes will be revealed.

A century of scientific research from the time of Dujardin, who discovered protoplasm, has revolutionised the fundamental conception of life. If the study of the protoplasm has fascinated the scientist, its revolutionary conclusions have rocked the very foundations of the philosophy of life. With the rapid advance of modern biology, the synthesis of living matter is not absolutely beyond the realms of possibility. The question arises, what is man going to do with this tremendous power, when he actually synthesises life ?

Man finds himself to-day in an amazingly paradoxical predicament. On the one hand he is marching with rapid strides with his advancement of scientific discoveries, so beneficial for the life and prosperity of the human race, on the other he is progressing with equal speed in the invention of terrible weapons of destruction, each deadlier than the other, cruel, inhuman and dastardly. The civilisation which the genius of generations of mankind has so laboriously built up appears to be on the verge of annihilation. It is, therefore, the more imperative that science maintains its correct ideal. Huxley said "No human being and no society of human beings ever did, or ever will, come to much unless their conduct was governed and guided by the love of some ethical ideal." To-day we can talk with the ends of the world more quickly than our grandfathers could get in touch with a neighbouring village, and a modern Phineas Finn of Jules Verne can go round the world in nearer eighty hours than eighty days. Wonderful achievements indeed, but let not scientific power work hell on earth. Wordswoth said

"The ever-living universe,
Turn where I might, was opening out its glories."

Let science reveal them, the more to heighten their beauty and their glory and thereby exalt the mind of man.

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SECTION OF GEOLOGY AND GEOGRAPHY

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Presidential Address.

A RE-EXAMINATION OF SOME ASPECTS OF PURANAS AND ARCHAEANS OF SOUTH INDIA.

INTRODUCTION.

I deem it a privilege to have been called upon to preside over the Geology and Geography section of the Indian Science Congress and I thank the members of this section for the honour done to me. This is the second meeting of the Indian Science Congress after our country has attained an independent status. Our freedom has been achieved at a time, when, after the cessation of war, the nations of the world have been all plunged into one of the worst socio-economic disturbances known to history. The expectations of the common man that the end of the last Global war would usher a new era of world brotherhood, international goodwill, economic co-operation, the 'four freedoms' of Roosevelt, etc., have faded out of vision. Powerful Nations of the world are engaged in selfish aggrandizement; while hatred, misrepresentation, mutual distrust and incriminations have come nakedly to the surface. We in India who looked forward eagerly to the dawn of our freedom and a new era of national renaissance and economic prosperity, worthy of our great heritage, have begun to wonder when that happy era is to dawn! Close on the heels of our freedom came the horrors of internecine murders and undeclared wars in which hundreds of thousands have lost their lives and millions have lost their homes and have been displaced. Other problems of "internal security," consequent on the attainment of independence have been staring us in the face. Politicians with patriotic fervour and record of political suffering have been called upon to play the roles of administrators to grapple with problems that would have proved formidable to the most experienced and seasoned statesmen. All the resources of the Government appear to be almost completely absorbed in tackling the immediate problems created in the wake of freedom and the partition of the country.

It requires foresight, a full knowledge of our natural resources, a critical appreciation of world economic trends, and sagacious planning, both for short and long terms, in order to be able to build up our national prosperity. With 80% of population dependent on agriculture and with sufficient water resources in the shape of our numerous rivers, we are in the unenviable plight of having to beg several of the countries of the world—big and small—for the very necessities of our life such as food grains, and pay inflated and dictated prices for purchasing them. Hopes of initiation of country wide industrialisation are kept up in casual public statements by our political leaders but tangible achievements are few. Half-hearted, ill-conceived, and ill-managed ventures in the industrial field are bound to result in failures most harmful in their after effects. It is easy to find adequate excuses for our not having been able to do any thing so far to solve the problems of our national poverty; excuses there always are to explain our failures. The money spent on technical and scientific education is like a drop in an ocean compared with our requirements. The observations of Professor Eric Ashby, a scientist attached to the Australian Legation in Russia in 1944-45 will be an eye opener to our government as to how U.S.S.R. has encouraged science. Professor Ashby is no admirer of communism. Even the modest recommendations of the Nehru National Planning committee drawn up during the previous regime seem to have been shelved.

In the renaissance of our nation Geologists and Geographers have a great role to play. These inter-related sciences are concerned most directly with the solution of problems of human happiness and prosperity, through material resources of environment. The knowledge of the mineral potentialities of this country is meagre beyond description, but even half-hearted and restricted attempts have brought to light mineral wealth which gives us some hope for our future.

It will be the function of the Geographer to correlate human existence to natural wealth and environment, to suggest policies of land utilisation, settlement of the refugees with the least hardship to themselves and the greatest advantage to the country. The Geographers and Geologists are probably the best equipped to advise on problems of provincial boundaries based on geographical, ethnological, and economic back-grounds. In the various schemes now taken up or contemplated in parts of India such as the Damoder Valley, Mahanadi, Kosi, Godavari and other projects, the services of the Geographers, Geologists and Engineers have to be fully utilised to get the maximum benefit out of these projects in all their aspects. When we ask ourselves the question if the role of the Geologist and the Geographer in the reconstruction of our country is adequately appreciated by the powers that be, we have sadly to realise that this has not been so.

Geology and Geography are probably the most neglected subjects in the Indian educational system of to-day. The few institutions and universities where these subjects are taught are struggling against odds to get adequate funds, facilities, and right type of teachers to give the youngmen a varied and practical type of training, so urgently greatly needed. There is a loud complaint from our administrators that we have not adequate scientific personnel to carry out responsible work. In the first place, it should be said that even the few persons who are trained to the B.Sc., Hons., and M.Sc., standards in these subjects, have not all been absorbed and it is pathetic to see youngmen, after having spent large sums of money for their education even upto M.Sc., stage looking hungrily for odd advertisements. The great majority of those who have taken their B.Sc., degrees in Geology known to me are now unemployed or have leaked into other walks of life such as customs preventive officers, motor part dealers, taluk office clerks, and High School teachers, called upon to teach subjects some of which they had never learnt. With this knowledge, the claims of our leaders that more men are required in scientific fields appears a mockery. Different grades of work in the geological line demanding different standards of attainment can be easily planned; useful and productive work suitable to youngmen possessing various academic standards of attainment can be easily provided. In my opinion it is unfair to condemn the attainments of any person merely on the results of a short personal interview for appointment to services, but this is inevitable in the present set-up.

We need an army of geologists; a few scores or even a few hundreds will hardly touch the fringe of the problem. The types of work initiated must be varied to utilise every available and qualified talent in this line to advantage. Scientific investigations should go hand in hand with economic development. There is no other short cut to the development of the full potentialities of our mineral wealth than by whole-heartedly plunging into the work with adequate personnel.

All of us acquainted with the Mineral Industry in this country, more particularly with reference to the winning of minerals are aware how wasteful, haphazard, and criminally neglectful, indeed, are most operations conducted by lay speculators without scientific advice and guidance. It would be useful if the Ministers connected with mines and mineral industry pay surprise visits to places where quarrying and mining operations are in progress, when they would realise the colossal wastage and the primitive methods of exploitation in these centres. Revenue Officials such as Collectors and Tahsildars and Forest Officers and Rangers are in authority to grant or recommend mining leases and to supervise mining operations, without any technical or expert advice or help. There is no unified control, much less a national policy, with regard to mineral exploitation and export. Even statistics of Mineral production are not completely known to such dignitaries as Directors of Industries and I had the queer experience of being referred to Collectors or Deputy Commissioners of districts regarding Mines and Minerals when a Director of Industries was approached for the supply of the statistics! It is doubtful if this problem is appreciated by the administrators in all its complexity and far reaching effects. The commercial and mercantile community, particularly with regard to mining industries, have with a few honourable exceptions sacrificed National interests before individual gains. It is for the people to determine whether there should be nationalisation or private enterprise, by their free choice.

We can take example from countries like the U.S.A. where private enterprise having the fullest scope gets the most helpful guidance from technical departments such as the Geological Survey and the Bureau of Mines; in return the government imposes well-conceived restrictions with regard to mining methods, optimum quantities for extraction and export. The history of mineral industry of Russia where there is whole sale nationalisation has also its good features, and offers us objective lessons in what can be achieved even during short and measurable periods. It is high time the Government faced fully and squarely the problem of our mineral industries and initiated measures to rigorously control it to subserve national interests. To barter away our raw materials in return for food stuffs, or for manufactured goods to maintain the balance of trade will keep us in perpetual economic subjection. A vigorous and bold policy is urgently called for in this direction even if it should cause annoyance or hardship to vested interests and powerful groups and combines. Defence problems and the possibilities of our being dragged into a war should not be ignored. Building up stock piles or reserves readily available for armaments and other war industries, not only of those minerals which may be termed "strategic or critical", but also in others that may be needed immediately must have the Government's priority attention. The task is colossal and requires the co-ordination of experts in several lines. I would invite attention to John B. DeMille's "Strategic Minerals" published in 1947 to appreciate how this problem was efficiently tackned in the U.S.A. during the last war. Even the modest recommendations for the reorganisation of the geological survey of India on the lines published in 1946 which is not quite adequate for our needs seems not to have been given full effect. We are told that there is yet another scheme under consideration by the Government which I hope is more broad based than the 1946 recommendations. The recently constituted Bureau of Mines has a very important role to play in our new set up and I hope that this organisation will co-ordinate the work of the Geological Survey and the Mines Departments, besides shaping the policies and practices concerning mineral exploration, exploitation, beneficiation, utilisation and export.

Instead of one School of Mines at Dhanbad, claiming to specialise in the applied aspects of Geology and mining, the Government must provide several Universities teaching geology, with facilities and funds to give advanced training in Applied Geology, besides strengthening the pure or academic side; without fundamental research, applied sciences cannot progress. The Geological Survey and the Bureau of Mines must be in a position to provide facilities for practical field training of the right type to aspirants without demanding prohibitive fees and imposing difficult conditions. I have no doubt that money spent on this object will be an investment for ensuring a bright future for the Mineral Industry.

Regional geographical surveys have to be initiated and our geographical education, largely negleced now, must be reoriented to subserve our immediate practical needs. We have yet to make headway with regard to facilities for technical education, training up of personnel, and opportunities of work for the few who are trained and available. We cannot live for ever on hopes and schemes which are often not based on well-thought-out plans. Economy in these directions will be suicidal to the national interests. The dream of solving our poverty will be an Utopia unless we tackle wholeheartedly and quickly the problems of utilising our natural wealth. Any thing detrimental to national interests should be unhesitatingly put down without consideration for personalities or vested interests.

The subjects of geography and geology in their practical aspects cannot be divorced from geo-politics and because of the deplorable state of this country I am constrained to make the above remarks, in the hope that our Government, supported by enlightened public opinion, will take early steps in the directions indicated.

I shall now turn my attention to the second part of my address in which I wish to put forward for your consideration some views regarding the Archaeans and Puranas of South India.

A RE-EXAMINATION OF SOME ASPECTS OF PURANAS AND ARCHAEANS OF SOUTH INDIA

In the early years of the activity of the Geological Survey of India, the pioneer geologists such as C. Æ. Oldham, Robert Bruce Foote, William King, C. S. Middlemiss and T. H. Holland traversed large tracts of Peninsular India and carried out reconnaissance survey and have given us the results of their observations in several publications of the Geological Survey of India amongst which "The Cuddapah and Kurnool formations" by William King[1], "The South Maharatta Country" by Bruce Foote[2], "The Geology of Pranhita-Godavari Valley" by King[3], "Geological Structure of the East Coast" by Bruce Foote[4], "The Sivamalai Series of Elaeolite-syenites and Corundum-syenites in the Coimbatore District" by Holland[5] and "The Charnockite Series, a group of Archaean Hypersthenic Rocks in Peninsular India" by Holland[6], to mention a few, constitute classics in the geological literature of Peninsular India. Considering the undeveloped nature of the country, the absence of communications and facilities for work in those times we cannot but marvel at the valuable contribution of these great pioneers in the realm of field geology.

During the last 18 years I had the opportunity to carry out revision survey in some of the areas in the Hyderabad State and in Madras Presidency either in collaboration with my colleagues in the Hyderabad Geological Survey or with my research associates of the Andhra University and it will be my attempt in this address to re-examine some aspects of the geology of the Purana formations and the Archaeans in the light of some field evidences and laboratory investigations Recent work of the officers of the Geological Survey of India in contiguous areas has also necessitated our re-examining some of these problems. In puttinng forward views divergent from those of the early pioneers like King or Foote or Holland, I wish to state that no disparagement is intended of their classical contributions. But I have to put before you some evidence collected from detailed field investigations, which appear to call for a revision of some of the views expressed by them in the stratigraphic correlation in some of the areas in South India.

THE PURANA GROUP

BHIMA SERIES : A RECLASSIFICATION

In his Memoir on the South Maharatta country Bruce Foote[7] recognised a group of unmetamorphosed shales and limestones in parts of Gulbarga district in Hyderabad State and in the contiguous parts of Bijapur district, Bombay Presidency, occurring in the Bhima-Kistna doab and gave them the name 'Bhima Series' and correlated them on lithological grounds with the Kurnool formations from which they are separated by a vast stretch of Archaean rocks. He divided the Bhimas into a lower series consisting of conglomerates, sandstones, and shales, and an upper series of limestones.

During a revision survey of Gulbarga district between years 1935 and 1941 it fell to my lot to cover the major part of the area occupied by the Bhima series[8] small portions of these formations being mapped by my colleagues in the Hyderabad Geological Survey, Mr. S. K. Mukherjee[9] and Mr. Syed Kazim.[10]

An area of over 2,000 square miles of the Bhima Series was covered in this survey. One of the important result of this revision work is the recognition of a threefold division of the Bhima Series as against the twofold division given by Bruce Foote. The results of my observations were communicated to the discussion on Pre-cambrian sedimentation in Bhima-Kistna basin to the Geology Section of the Indian Science Congress, 1938[11]. This was further elaborated in the Memoir[12] on "Bhima Series and other rocks in Gulbarga district". The total thickness of the Bhima Series has been computed to be about 1,225 feet of which the lower Bhima Series consisting of basal conglomerates, sandstones, and shales, are 350 feet, the Middle Bhima series consisting of limestones, accounting for about 550 feet, and the Upper Bhima Series[4] made up of local sandstones, shales, and flaggy limestones, have a thickness of 325 feet[13].

Two dolerite dykes cutting through the limestones of the Lower and Middle Bhima Series were traced for distances over 5 miles[14] similar to the dolerite intrusives reported by J. B. Auden in the Vindhyans of the Son valley[15]. This observation gains importance from the fact that Sir L. L. Fermor[16] distinguished only two groups of basic dykes prior to the Deccan Traps, one contemporaneous with the Dharwar system and the other younger than the Cheyair stage of the Cuddapahs. Several faults[17] of Pre-Trappean age had also been brought to light during the survey in the Puranas of the Bhima-Kistna basin.

THE PALNADS

The age of the Palnad series north and south of Kistna in the districts of Guntur in Madras Province and Nalgonda in the Hyderabad State was a matter of controversy between two of the pioneers of South Indian geology namely King[18] and Bruce Foote[19]. King was of the opinion that they were of Kurnool age whereas Foote was inclined to the view that they might be classified with the Kistna beds which are the upper most of the Cuddapah system. The reason for this controversy was the absence of a recognisable unconformity between the Kistnas and Palnads in the area covered by them.

While working for the Hyderabad Public Works Department on the north bank of the Kistna in Nalgonda district in the year 1933, I had occasion to examine the area between Nandikonda and Wazirabad in some detail. In a paper read before the Science Congress, 1934[20], I pointed out the occurrence of definite conglomerate beds about 3 miles east of Nandikonda (16°-35': 79°-18'). These conglomerate beds, which are quite hard and compact, contained pebbles of the Kistna series and marked the eastern limit of the upper Cuddapah beds. Further east these conglomerates are succeeded by shales and limestones of the Palnad series. Another very significant fact in these conglomerate beds is the presence of old and extensive workings presumably for diamonds. It appears that these conglomerates 3 miles east of Nandikonda, which form the base of the Palnads correspond to the Banganapalle beds. A large number of limestones from the Palnads north and south of the river which were analysed, showed from about 75 to 90% of calcium carbonate with magnesia in negligible quantities.[21]

Lithologically and chemically these show the closest similarity to the Narji limestones, which are of undoubted Kurnool age, to the Bhima limestones[22] and to the Sullavoi limestones[23], which have been correlated with the Kurnools. In contrast to the Palnad limestones, the Cuddapah limestones give uniformly much lower values for calcium carbonate and greater values for magnesium carbonate.[24] [25]

Subsequent to this work, my colleagues Mr. S. K. Mukherjee[26] and Mr. Syed Kazim[27] surveyed the area but Mr. Syed Kazim who worked to the east of the Musi river met with only the Palnads and Mr. S. K. Mukherjee was handicapped on account of the nature of the country from doing any detailed work in the Chintalapalem-Nandikonda area.

Dr. A. M. Heron,[28] who visited the area alone and in company with our colleagues, records his observations in an interesting and thought provoking paper on "The Correlation of the Cuddapahs and Kurnool formations along the Kistna" wherein he makes a novel suggestion that the Palnad group (consisting of basement sandstones and shales followed by 21,000 feet of limestones 8,000 feet of shales upto the quartzites of the Mladarsal Ridge) were deposited in a basin of subsidence quite apart from the Cuddapahs and remarks, "In the Palnad basin subsidence may have commenced later, not long before the deposition of the Cuddapahs had finished in the main basin, and continued with far greater regularity and in deeper water, as is shown by the immense accumulation of the uniform limestones and shales, interrupted only by the diamondiferous grits." It may however be mentioned that this thickness is computed from the angle of dip of the limestones from Huzurnagar Taluk area. Dr. Heron's estimates of the thickness are not in conformity with those of either King and Bruce Foote and may probably be explained as being due to other factors as he himself suspected.[29] Dr. Heron makes the significant remark, "The relationship of the 'Palnad limestones' to the Cuddapahs, except that the former are younger than the latter, is left unsettled and will have to await the resurvey by the Geological Survey of India of the Cuddapahs and the Kurnools in Madras Presidency."

Since my joining the Andhra University in early 1945, the Palnad area has been receiving the attention from the Geology Department of the University. Two of my research scholars, Mr. T. Madhusudhana Rao and Mr. M. Krishna Murty (Theses submitted for M.Sc., 1948) have adduced evidence on structural, lithological and chemical grounds, to show that there is a clear disconformity between the Cuddapahs and the Palnads in the Taluks of Narasaraopet, Vinukonda and Guruzala. A summary of this work is presented before the Geology Section of this year by Mr. M. K. Murty and T. M. Rao. The work is being continued by other research scholars of my Department during the current academic year also.

There does not seem to be any formidable difficulty (except the computed thickness by Dr. A. M. Heron) from the available field and laboratory evidence, in considering the Palnads as homotaxial with the Kurnools and later than the uppermost Cuddapah beds and separated from the latter by a recognisable disconformity. Much work, however, remains to be done systematically in this area.

THE PAKHALS

King,[30] in his Memoir on the Pranhita-Godavari valley, recognised certain sedimentary formations in the neighbourhood of Pakhal village adjacent to a lake of the same name, and at Sullavoi further north-west. The Pakhals are found eastward and northward occupying considerable areas in sheets No. 65 C|NE and 65 C|NW, and extend further north and south of the sheets. In these sheets they are fringed by granites to the south. They are also seen to be overlain by Gondwana formations, particularly the Kamthis. King correlated the Pakhals with the Cuddapah group and the Sullavois with the Kurnool series. He remarks; "They are associated by the same very decided and remarkable system of movements and metamorphisms which were exhibited at a particular period in the foundational rocks of the Peninsula; they are, to all appearance, lithologically identical; and, on the very face of the map, they are just a northerly continuation of the great field of the Penner and Kistna basins." He recognises, however, that the correlation of the subdivision of rocks with the groups of Cuddapah series has not been possible. In the subsequent paragraphs, writing about the Singareni region, he observes that there is evidence there of much crushing and folding and the rocks are considerably altered or changed from their normal style of easily recognizable quartzite conglomerates and sandstones, clay slates, and compact grey or fawn-coloured splintery limestones.

In the year 1941 the area was taken up for detailed geological mapping by the officers of Hyderabad Geological Survey[31] and I had the opportunity of mapping the major part of sheets 65 C|NW, C|NE and of studying the relationship of the various geological formations met with in this area during the field seasons 1941-44. I shall record here certain field observations made during this survey, which appear to show conclusively that the Pakhals are not homotaxial with Cuddapahs[32] but constitute a group of metamorphic rocks comparable lithogically to the Gangpur series,[34] which are assigned to Middle Dharwar age.

In sheet 65 C|NW (Singareni Collieries sheet) there are three distinct granitic bays south of the Pakhals, one passing through Karapalli railway station to north of Mukundapur, another from Tekulapalli through Yellandlapad to Munditok and the third in the Bethampudi area. In all these places there is the clearest evidence of the intrusion of granites into the phyllites and limestones of the Pakhal series. Typical hybrid rocks at the contacts are most conspicuous. Xenoliths of the Pakhals are found in the granites at considerable distances from the contact zone—for instance in the villages of Pirpalli, Karapalli and near the fourth milestone on the Singareni Collieries-Borgampad road. In the Bethampudi area the granites show similar intrusive relationship to the phyllites at a number of places. Pegmatite veins frequently cut through the Pakhals. The quartz veins which are instrusive into the Pakhals in this area are blue and mottled rather than milk-while. Andalusite bearing zones are developed between the villages Mulakalapalli, Rabingudem, Ravalpad, and Dandagundala adjacent to quartz intrusives and in between the Bethampudi and Yellandlapad granite bays. North of Bethampudi, in a stream, andalusite and staurolite are recognised at the contact of granites and phyllites. North of village Kuntala, about a mile and half N.N.E. of Bethampudi, chiastolite is met with in the phyllites and mica-schists.

In sheet No. 65 C|NE (Kothagudem Collieries and Paloncha area) the Pakhals outcrop north of lat. 37°, running N. N. Eastwards for a distance of over 20 miles. They have a width over 15 miles in places. They are fringed towards the south and east by granite gneisses for a considerable part and are capped by Kamthis to the west and north, by the Talchirs to the north-east. The granites all along the southern margin show very clear evidence of intrusion into the phyllites.

King remarks about this area[35]; "The Yenkatapur beds are continued under the Kamthi sandstones of Paluncha and appear again in the Mamla hills, at the southern end of which, near Yellambail, the limestone bands also again show in all their altered character, semi-crystalline and saccharoid, but now profusely laminated with silicious matter and some tremolite. The beds are thick and running with a tolerably even strike; but their laminae are twisted, folded and swollen out in the most curious way, while they roughen the surface of the rock with outstanding sinuous little ridges.

"Here, too, the relations of these Kadapah strata and the gneiss alongside, are much obscured by the highly altered and schistose character of the quartzites and other beds; so much so, that I must qualify the lines I have drawn in on the map as to a very great extent doubtful, especially at the Yellambail end. My colleague W.T. Blanford, who first passed over this part of the country, only noted at the time that portions of the higher part of the range are probably of the transition rocks, but I was subsequently obliged to look on most of it as of this series."

As remarked by King it is often difficult to mark the boundaries of Pakhals and phyllites accurately; I found that the interaction zone was widespread. Large patches of inclusions of Pakhals occur at a distance of over half a mile from the boundary and granite phyllite interaction rocks, typically hybrid in nature, are met with in the body of the Pakhals. The granites here are hornblendic, and aplitic and towards the eastern margin there are typical injection and composite gneisses. A few minor patches of Dharwars occur in the granites south of the Pakhals but one patch which occurs to the east of Mailaram, consisting of hornblende-schists, is of particular interest in that it fringes the Pakhals to the east and west and granites to the N.E. and south which are intrusives into the schists. The relationship of the hornblende schists to the Pakhals here is not very distinct but they have the same structural features common to the Pakhals namely N.E.-S.W. strike and dip at nearly the same angles (at 60°-80°). It is surmised that they may correspond to the Lower Dharwars in this area.

In sheet 65 C|NE the quartz veins occur in far greater abundance than in sheet 65 C|NW and they are typically like the blue and mottled quartz vein of Dharwars. During the course of my survey, two old workings presumably for copper, one of them about 400 feet long and the other 1,500 feet long, with an average width of about 50 feet, were met with about a mile north of Yellambailu, in the mineralised quartz vein cutting through the Pakhals. Subsequent survey disclosed another old working for copper over 1,200 feet in length, about 2 miles south west of Mailaram. I found in the vicinity of this village evidence of *mullackers,* and extensive slags. The dumps showed frequent patches of malachite and azurite. Chalcopyrite and covellite could also be recognised in the runs of blue quartz veins.

Now the rocks met with in the Pakhals may be grouped as quartzites, phyllites and marbles. The phyllites are the most important rock types which frequently grade into sericitic and micaceous schists. A close study of the rock types has revealed the following members in Phyllites in the Singareni area from west to east:

Description of the rocks.	*Approximate trend.*
	(65 C|N.W. square reference in brackets).
(1) Micaceous quartzites and siliceous phyllites.	Suddarevu, Koiagudem, Kasampalli (C|3), Navalpad and Cheruvupuram,

(2) Puckered chloritic micaceous phyllites.	1368' hill (C|4), Kambalpalli (C|5), Metlagudem (C|5) Kottur C|6) line.
(3) Carbonaceous and bluish slates (chloritic in part with micaceous inclusions).	East of 1368' hill (C|5) Lachapuram (C|1), Muthyalammagudem (C|5), Danyalpad (C|5), Kosapalli (C|6) and east of Kottur (C|6).
(4) Micaceous phyllites and quartz-phyllites (?)	Mamdigundal-Mukundapur line.
(5) Carbonaceous and bluish slates.	About 1½ miles west of Mittapalli (D|5) extending south to a mile east of Mamidigundal and thence to further S.E.
(6) Garnetiferous and staurolitic micaceous schists.	1½ miles east of Mamidigundal extending south east on the western flank of the hills east of Lachaguda (D|5) and further S.E. to Polampalli village (D|6).
(7) Phyllitic-granite interaction rock.	East of Takalagudem (E|6), east of Yepalaguda (E|6), (4M. 7F. to 5M. stone), 2 miles west of Ravalpad on the western flank of the hills fringing either side of the Pubali tank, a mile south of Munditok quarries.
(8) Puckered and fritted micaceous phyllites.	Hill range from 5M. 5F. stone to south (N.W. of Rabigudem (E|6) and to 1517 hill a mile W.S.W. of Ravalpad, Dandigundal (E|5).
(9) Mica-andalusite-garnet schists.	East of the above line, from west of Mulkalagudem (E|6) to west of Ravalpad (E|5) with probable extension to Dandigundal.
(10) Micaceous phyllites and schists.	East of the above line and parallel to it.
(11) Carbonaceous phyllites and micaceous schists.	9th M.S. on the road to west of Abareddigudem and west of Tumalchilka (F|5) with southern extension to a mile east of Robingudem.
(12) Staurolite-andalusite-micaceous phyllites.	East of the above line and parallel to it (north of Bethampudi).
(13) Micaceous phyllites puckered and foliated.	East of the above, north of Bethampudi; Madirayala and Tumalchilka (F|5).
(14) Carbonaceous phyllites and schists with chiastolite (?)	Kuntala and further north and north-east.

The quartzites occur interbanded in the phyllites and they show a close knitted and occasionally micaceous aspect and frequently contain small crystals of garnets. The calcareous bands which extend in a south to north direction are typical highly crystalline, saccharoidal or coarse grained marbles. They show frequently ptygmatic folding and banding and the original impure calcareous sediments along the margins give rise to actinolite, tremolite and wollastonite.

Mr. E. Venkayya of the Geology Department, Andhra University, is now engaged in a detailed study, in collaboration with me, of the Pakhal rocks collected during my work.

On the way to the Munditok quarries, hybrid rocks resulting from the interaction of granites and marbles are frequently observed. Garnets are in fact found throughout the Pakhals, more especially in association with phyllites, which are mostly micaceous. The beds have generally a N.E. strike and S.E. dip, the amount of dip varying from 60° to almost vertical. There are also indications of anticlinal folds of some magnitude, pitching northwards both in the Singareni and Kothagudem sheets.

The mica-garnet-staurolite schists occur between Polampalli, Kummaguda and Mamidigundala. Carbonaceous phyllites have been noted at a number of places between Kumbararam and Samulagudem and in the neighbourhood of Tumalchilka and extend further north with the same trend. In the Yelambailu area the phyllites often grade into micaceous schists with abundant development of garnets and here too a variety of metamorphosed argillaceous types with interbanded quartzites and marbles are recognised. My colleague Mr. L.S.K. Murty adduced evidence in his reports to show that the granites are definitely intrusive into the phyllites further south of the above area, mapped by him. The hills composed of the kyanite-garnet-mica schists near Garibpeta have been shown by Mr. Murthy to be part of the Pakhals.

In the Yellambailu area, I have come across basic intrusions near Kothurugudem at the confluence of a stream with the Kinnerasani river about 4 miles S.E. of Yellambailu. Similar basic intrusions have been also noted in the Bethampudi and Singareni areas. Dr. Heron who has seen most of this area either with me or by himself agrees that there is granitic intrusion into the Pakhals but suggests that these granites might be of a later age than the Peninsular granites. We do not know of any such granitic intrution in the type area of the Cuddapahs in the Madras Province.

It appears that there is very little doubt that the Pakhals are really of the Dharwar age and are probably comparable to the middle Dharwars or Gangpur series. It also appears to me that the hornblende schists of the area which occur in minor patches either adjacent or in proximity to the Pakhals, correspond to the lower Dharwars in this area. I, therefore, venture to suggest that the Pakhals are not homotaxial with Cuddapahs but correspond to the Middle Dharwars for the following reasons:

1. No where have we seen an unconformity between the Pakhals and the granites.

2. The Pakhals dip at high angles and show folding and pitching and the sediments have been metamorphosed to micaceous garnetiferous phyllites and mica schists with garnets, staurolites, andalusites, chiastolite and kyanite, garnetiferous and micaceous quartzites, tremolite-actionlite schists and marbles, a feature never known to occur in the Cuddapahs.

3. Lithologically the Pakhals are most dissimilar to the Cuddapahs and afford no comparable correlation, as admitted even by King[37].

4. The granites are distinctly intrusive into the Pakhals, producing wide-spread contact effects, whereas the Cuddapahs rest unconformably over the granites, as is evident all along the junction.

5. The occurrence in the Pakhals of mineralised blue quartz veins with old workings for copper ores points to the similarity of the Pakhals to Dharwars rather than to the Cuddapahs.

To the east of Thimmapur (lat. 17°-46', long. 80°-8') there is a very distinct disconformity between the Sullavois and Pakhals. The Sullavois in this area begin as a conglomeratic bed and further north grade into khaki coloured shales and occasionally into crypto-crystalline limestones. A similar relationship was noted in the neighbourhood of Ramagundam station, in Karimnagar district, between Sullavois and Pakhals. I have also a suspicion that in the heart of the Pakhal country such unmetamorphosed sedimentaries cap the Pakhals with an unconformity. These group of rocks probably represent the Cuddapahs and Kurnool types in the area. Due to talus cover and thick forests, sections exposing the unconformity between the metamorphosed Pakhals and unmetamorphosed sediments are few and far between.

ARE THE PAKHALS HOMOTAXIAL WITH THE KHONDALITES?

Subsequent to the mapping of sheet No. 65 C|NE in the field season '42-'43 and part of '43-'44 I had the opportunity of working in the Godavari Gorge area, particularly in the Papikonda range and the area to the South-west of that. The formations here consist of khondalites in which are included the quartzites, sometimes garnetiferous, and sometimes containing graphite, normal khondalites containing sillimanite, garnet, and graphite, mica-schists, calc-gneisses and crystalline limestones. These are intruded by basic plutonic rocks and granites and fringed on the north-west by corundum syenites, which also bear zircon. These khondalites are very nearly in the S. E. continuation of the Pakhals of Paloncha, Yellambailu, the Kothagudem and Singareni sheet areas and are separated from these by the Kamthi formations just as the Pakhals of the Singareni area and Pakhals of Yellambailu are separated by a band of Kamthis. In the Pakhals we meet with micaceous schists, garnetiferous phyllites, mica-garnet-staurolite schists, mica-garnet andalusite schist, mica-garnet-kyanite schist, carbonaceous phyllites and marbles. Evidence has already been adduced to correlate these Pakhals to the Dharwars of Gangpur area and it has been suggested that they probably correspond to the middle Dharwars. It appears that the same type of rocks when subjected to higher grade of metamorphism give rise to rock-formations extraordinarily similar to the khondalites. Structurally too, the khondalites have the same strike (N.E.-S.W.) and dip, as the Pakhals. Work by the Geological Survey of India in Bihar, Orissa and Central Provinces has resulted in the recognition of a progressive metamorphism in the Dharwars of those areas. We are probably, therefore, justified in considering that the khondalites are highly metamorphosed Pakhals and that both belong to the middle Dharwars. In a paper presented before the annual meeting to the Indian Academy of Sciences at Udaipur[38] in December '45 this correlation was suggested.

AGE OF THE KALADGIS

The Kaladgi series occurring in Bombay Presidency were considered by Bruce Foote[2] to be homotaxial with Cuddapahs mostly on lithological grounds. These are separated from the type Cuddapah area by vast stretch of Archaean rocks. Recently Dr. L. A. N. Iyer[39] from the Geological Survey of India in his interesting paper on the Geology of South Ratnagiri has noted clear evidence of the intrusion of granites, basic and ultrabasic rocks into the Kaladgis. He[40] records; "Formerly, the rocks of this area were supposed to consist of only sedimentary formations, but the present survey has proved that in part these have been intruded by acid and basic rocks, and have been subjected to contact metamorphism by the granite intrusions. Previously these granites and gneisses were considered to be metamorphic in origin and to underlie the whole of the area, and the intrusive nature of the granite was not recognised." Besides the metamorphosed series there are also unmetamorphosed sedimentaries in this area just as there are in the Pakhal area. In many respects, the Geology of the South Ratnagiri area is similar to that of south Singhbhum, where both matamorphosed and unmetamorphosed sedimentaries occur in association, and the metamorphosed sedimentaries show clear evidence of the intrusion of the granites, the basic rocks and the ultrabasics, the ultrabasics in that area[41] giving rise to the chromite deposits as they indeed do in the Ratnagiri area[42].

From these recent studies, it is apparent that a great deal of detailed and careful mapping with due appreciation of the inter-relationship of the formations in the area mentioned above is essential. It appears to me that in the earlier reconnaissance survey the sedimentary metamorphosed members into which the granites and other igneous rocks were intruded and which are therefore very probably of pre-Peninsular Crystalline complex age (Dharwar) have been uncritically associated with unmetamorphosed sedimentary formations belonging to the Cuddapah and Kurnool system, which sometimes occur contiguously with them. It is significant that in all the geological sections given by Dr. Iyer[43] nowhere do we see an unconformity between granites and the sedimentary series. Just as in the case of Pakhals it appears that the Kaladgis, at any rate a major part of them, are of Dharwar age.

ARCHAEANS

KHONDALITES & ASSOCIATED ROCKS

One other problem on which I may perhaps make some observations in the light of my field work in the Papikonda range and adjoining areas on the right bank of Godavari in Warangal district, is on the khondalites and associated rocks. Happily my interest in these groups of rocks[50] has been sustained in the Andhra University with the co-operation of some of my research scholars who have taken up the study of the geology, petrology and petro-chemistry of the khondalites and associated rocks in the districts of Vizagapatam, Kistna and Guntur.

Some of the results of this work have been published and others are awaiting publication. We have now come to a stage when we may perhaps attempt a correlation of the khondalites with similar formations in other parts of Peninsular India. From a perusal of the literature pertaining to the geology of South India it is evident that Bruce Foote and King[45] used the terms schistose gneisses to denote the khondalitic rocks as well as members of the Dharwars whereas the members of the Peninsular gneisses were designated as massive gneisses or granitoid gneiss. The Bezwada gneiss series of Bruce Foote and King consist of a series of rock types which are metamorphosed sediments ranging from quartzites to crystalline limestones with all the intermediate groups that have been completely altered by regional metamorphism, and as pointed out by Dr. Krishnan[46], [47] they are lithologically very similar to the khondalites of Walker..[48] The intrusion of these paragneisses by granitic material giving to migmatites was recognised by King, Bruce Foote and Middlemiss.[49]. Our work in the Guntur district has established that the same group of rocks with similar intrusive associations continue at least as far south as Kondavidu.[50]

Mr. A. Narasingarao[51] who studied the Kondavidu hill ranges, finds both, charnockites and granites intrusive into the khondalites. He has shown from field study, chemical analyses and optical examination of various rock types, that the leptynites result from the recrystallisation of the khondalites along the contact zones of granitic intrusions. Dr. M. S. Krishnan,[52] who worked in the Kondapalli area in connection with the chromite deposits, drew attention to this feature, when I visited him in 1943, where the khondalites have been recrystallised to form leptynites in proximity to the charnockitic intrusion. Mr. Ch. Narasimharao[53] has also confirmed this conclusion from his work on the Kailasa range in the Vizagaptam area.

As regards the charnockites of Kondavidu. Mr. Narasingarao concludes that the intermediate charnockites result from the interaction of the basic type with the granites, as seen by the shift in the isofalic point towards the silicious side, a view which was recognised by Mr. Sriramrao[54] in his study of the "Petrogenesis of the Charnockites of the Kondapalli." One interesting mineralogical observation in the study of the charnockites of the Kondavidu area was the identification of a hypersthene showing a positive optical sign[55]. The unique association of chromite with charnockites first reported by Krishnan in the Kondapalli area stimulated the interest of others in these rocks. Mr. Sreeramarao,[56] Mr. N. Venkatappayya[57] and Mr. Cheluva Iyengar[58] are inclined to consider the chromite associated with basic charnockites as both magmatic and hydrothermal in origin.

Krishnan[46] has drawn attention to the much needed correlation of the various types of garnetiferous paragneisses of South India and has suggested that the term khondalite originally applied by T. L. Walker[59] to these rocks in the Kalahandi State may be extended to the Bezwada gneisses of Foote and King, the Kailasa gneiss and the Vizianagaram gneiss of King as also the garnetiferous gneisses generally associated with the charnockites in the southern Districts of Madras Presidency. All these paragneisses which have been subjected to high grade metamorphism can now be brought under the category of khondalites. It is noteworthy that, whereas prior to the distinguishing of the paragneisses of Orissa and Vizagapatam as constituting one group by T. L. Walker, local names such as Bezwada gneiss and Kailasa gneiss, Madura gneiss, Tinnevelly gneiss, Coimbatore gneiss were given by the earlier geologists, the term khondalite has been used unhesitatingly to designate similar rocks in Ceylon and Travancore on account of the fact that work was carried on these formations subsequent to Walker's nomenclature, when it was not difficult to appreciate their consanguinity.

The paragneisses of Madura and Tinnevelly district described by Foote[60] consisting of cordierite-biotite-garnet gneiss, with frequent associations of graphite, quartzite and crystalline limestone bands appear to be typical khondalites into which, as in the type area, granites and charnockites are intruded. I visited some of those areas in Madura and Tinnevelly and have also studied several micro-sections of these rocks in connection with the work on pleochroic haloes [61] and was impressed with their similarity to some of the khondalites. The cordierite gneisses of Pachipenta area [62] which are full of pleochroic haloes show a positive optical sign as do some of the cordierites of Madura, described by Krishnan[63].

Another evidence supporting the view that the paragneisses of Madura and Tinnevelly areas are homotaxial with the khondalites is furnished by Dr. Jacob.[64] Dr. Jacob has recorded the occurrence of beach sands containing magnetite, ilmenite, monazite, zircon, garnet, rutile, hypersthene, sillimanite etc. in the east coast of Tinnevelly, Ramnad and Tanjore districts. The similarity of the beach sands of Travancore[65], derived from the khondalitic and associated rocks and the beach sands of Vizagapatam[66] derived from the khondalites and associated rocks of this area to the beach sands of Tinnevelly and Ramnad coasts, is striking and provides another reason to justify the assumption that the paragneisses of the southern districts of the Madras Presidency are also khondalites. The recognition of the fact that all these paragneisses are correlated to the khondalites and may be called as such will simplify greatly the confusion of local names now in vogue in South Indian geological terminology.

A very nteresting fact accruing from a detailed study of the khondalite areas by us in the Andhra University in the districts of Guntur, Kistna and Vizagapatam refers to the stratigraphic position of the khondalites. To my knowledge this has not been seriously attempted so far. In all the descriptions of khondalites since Walker's time emphasis has been laid on the most common members of the khondalitic group characterised by the presence of quartz, garnet, felspar, sillimanite and graphite, ignoring almost entirely the arenaceous and the calcareous members as well as the schistose formations which occur so characteristically interbanded in them.

In the Bison hill range of the Godavari valley these schistose formations which occur interbanded amidst the normal sillimanite-graphite gneisses are of some magnitude both in width and trend. Some inter-banded crystalline linestones are adjacent to the mica schists. Pegmatite veins which cut through the gneisses and schists in this area have given rise to deposits of coloured mica which was thought to be phlogophite from its colour but which has now been identified as a new type of mica by Mr. Ramaseshan,[67] working with Prof. Sir C. V. Raman. I have recently come across an identical type of mica from East Godavari district, the properties of which are briefly described by Mr. E. Venkayya[68] at this Session. Dr. M. S. Krishnan informs me that some of the mica found near Singampatti in the Tinnevelly district is also similar.

It is still not on record in geological literature except in a note by Gopalakrishnamurty and Mahadevan in Current
deposits of muscovite mica of the finest quality have been located in pegmatites intrusive into the schists occurring interbanded as a member of the khondalitic series in the Tiruvur area of the Kistna district. Mr. Gopalakrishnamurty[70] who mapped the area and studied the deposits both in the field and in the laboratory, records the occurrence of apatite and tourmaline besides large books of muscovite and biotite, in the pegmatites.

In the Kurupam Zamindari, Vizagapatam district which I visited in April 1947 similar mica deposits in pegmatites cutting through the schist bands in the khondalites were noted. Here translucent beryl and tourmaline occur as accessories in the pegmatites and the muscovite mica is of a fine quality, almost free from spots. Mr. G. Gopalakrishnasastry[71] recorded similar deposits in the Pachipenta area. He has attempted a correlation of the khondalitic series and gives the following succession in his area:

Crysalline limestones
Diopside quartzites
Sillimanite-garnet gneisses
Garnetiferous gneisses
Biotite gneisses and Mica schists.

There seems to be little doubt that the schistose formations of the Nellore area which are marked as Dharwars, are very similar to those of the Tiruvur area in Kistna district, the Kurupam and Pachipenta areas in Vizagapatam district, and West Godavari areas described by Dr. Krishnan.[72] Similar schist bands occur as part of the khondalites in the Kondavidu area. Another note-worthy feature confirming this correlation is the recognition of chalcopyrite in the pegmatites and quartz veins of Tiruvur area by Mr. N. Gopalakrishnamurty[69] and by Mr. Ch. Narasimharao,[73] in the neighbourhood of Vizagapatam. Copper staining was also noted by me in the khondalites southwest of the Papikonda range in the neighbourhood of the village Kavarigundla in blue quartz veins with disseminated chalcopyrite.[74]

The schistose series of the Gudur area consist of garnet mica schists, with kyanite and staurolite. The Nellore mica belt is on the same strike as the khondalites and there is every reason to suppose that it is merely the continuation of the khondalite zone. The occurrence of mica in the schistose members of the khondalitic rocks and the mica schists of Nellore and of copper minerals in Garimanipenta of Nellore district and in khondalites further north do not seem to be an accidental coincidence.

Dr. Krishnan[75] makes a passing suggestion that the khondalites are probably homotaxial with the middle Dharwars. Adequate evidence has been put forward to claim that the so-called Dharwars of Nellore are only a phase of the khondalites of the Eastern Ghat region.

SUMMARY

An effort has been made in this address to show that the Bhimas may be divided into three groups namely, Lower, Middle and Upper, that basic igneous activity continued upto the Kurnool stage in south India; that the Palnads are comparable to the Kurnools in stratigraphic position and that the Pakhals and Kaladgis are not of Cuddapah but of Dharwarian age. The khondalites are only a more metamorphosed phase of these Pakhals.

As regards the khondalites, an attempt has been made to correlate the paragneisses of South India with the khondalite group. That some of the Dharwars of South India such as those of Nellore are merely the schistose phase of the khondalites has also been shown.

I am conscious that I have attempted to sum up very briefly evidence on various topics connected with Peninsular Geology each one of which by itself deserves an elaborate treatment. There may be divergence of opinion with regard to some of the views put forward here. But I shall be content if I arouse the interest of my Geological colleagues in these problems which need much careful study and elucidation.

ECONOMIC IMPLICATIONS IN THE LIGHT OF THE ABOVE RECLASSIFICATION

It would be worth enquiring what are the economic implications of the regrouping of the Puranas and the Archaeans attempted in this address. Any conglomerates exposed at the base of the Palnad series may be worth searching for diamonds. The limestones of the Palnads which have been shown to be homotaxial with the Kurnools offer abundant and unlimited material for the manufacture of cement on account of their low magnesia content. Good flagstones similar to those in the Kurnool strata are also to be expected.

The Pakhals yield good deposits of true marbles of variegated colours for decorative and ornamental work. They are frequently dolomitic in composition[76], and are very similar to the marbles of the Gangpur series which are exploited for both limestone and dolomite[76] These are greatly needed in the metallurgical industry in the area. Staurolites, andalusites and kyanites in the Pakhals may find use as refractories or even as abrasives and may be in demand in future industrialisation. Garnets in the Pakhals are not only useful for abrasives but have also a value as cheap gems. The possibility of locating new copper deposits and of reopening some of the ancient working discovered in the Yellambailu area are worthy of careful investigation. Blue quartz veins cutting through the Pakhals, especially in Yellambailu and Bangaruchilka areas, are frequently mineralised and in my opinion are worth careful examination for their metalliferous content.

In the khondalites it is now known even from the meagre survey carried so far that workable deposits of graphite occur at a number of places. Specimens sent to the Geology Department of the Andhra University by several prospectors and the evidence gathered by the research scholars during the course of their survey work are encouraging enough to warrant optimism in this line.

Reference has already been made to the mica-bearing pegmatites in the Tiruvur area of Kistna, the Kurupam Zamindari and Pachipenta area. Several samples of similar muscovite micas, as also of phologopite and the new type of mica, have been sent to us for examination and it appears probable that several new deposits will come to light in the khondalitic area in the Circars and Southern districts.

If the khondalites are recognised to be a part of Dharwar system as I attempted to show, a new vista of the economic possibilities is opened up and geologists and prospectors will be warranted in keeping a look-out for economic minerals such as those found in the Dharwars.

The discovery of chromite in the charnockites of Kondapalli has completely altered the economic aspects of the charnockitic formations of South India. Though our present knowledge of similar occurrences elsewhere is negligible, the potentialities are distinctly encouraging. Is it too much to hope that more concentrated and systematic work by a large number of

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SECTION OF BOTANY

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NATURE CONSERVATION, NATIONAL PARKS AND BIO-AESTHETIC PLANNING IN INDIA

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Gentlemen, the subject which I have chosen for my address—the problem of "Nature Conservation, National Parks and Bio-aesthetic Planning in India," is one not of merely botanical interest. It deals with a problem which requires the urgent attention of the biologists, administrators, legislators and all thinking citizens. The problems of conservation of nature attracted attention of biologists in most progressive countries of the world. In the United States of America the first national park for the preservation of fauna and flora was established in 1872. In United Kingdom a special committee was appointed in 1945 with Dr. J. S. Huxley as Chairman and Professor A. G. Tansley as Vice-chairman to consider the general problems of wild life conservation and the scientific and administrative requirements. The special committee submitted its report on "Conservation of Nature in England and Wales" to the Minister of Town and Country Planning who presented it to the Parliament in July 1947. This report contains many suggestions which can with advantage be adopted in this country as well.

The concept of nature conservation embraces several distinct purposes such as conservation of plant and animal life, the scientific aspect which includes biological research, field research and experiment; the amenity aspect which deals with aesthetic and recreational side and the educational aspect. The aesthetic and recreational approach placed the main emphasis upon preserving the characteristic beauty of the landscape and upon providing ample access and facilities for open-air recreation and for the enjoyment of beauty in those areas. The major features of the Park are made easily accessible by providing roads, trails and bridges, and living accomodation in the form of hostels etc. The scientific approach which in no way underestimates the aesthetic values, was primarily directed to the advancement of knowledge and its application to human welfare. "The educational aspect" as the Special Committee on Wild Life Conservation observes "is in many ways complementary to each and all of the others. True appreciation of scenery rests in part upon, and is certainly enhanced by, some understanding of the rocks and the variety of landscape which these induce, the shapes of of the rocks and the variety of landscape which these include, the shapes of the valleys and summits, the flow of the streams, the cliffs and dunes and flats of the coast, and all the rich verdure with which they are clothed, are things which can invigorate and refresh the mind and upon which a deep culture can be based. The more widely this appreciation can be diffused, the sounder will be the mental and physical health of the nation", The type of areas which are in need of conservation can be classified under the following categories:—

I—*National Parks and Nature Reserves*: National Parks may be defined as extensive areas of beautiful and relatively wild country with characteristic landscape beauty, which are also wild life sanctuaries for the preservation of big game, or other mammals and birds, in which access and facilities for public open air enjoyment are also provided, so that the people may be able to observe wild life of all kinds in its natural surroundings at close quarters. There is also need of nature reserves in the national parks, which act as breeding reservoirs for shy animals, which it is desired to encourage and which are not accessible to visitors.

II—*Geological Monuments and other areas of outstanding value*: These include rocks, exposures or sections which because of their great geological interest should be preserved as Geological Monuments, and which should be given the same protection as to archæological buildings and monuments. These should be protected from mining, excavations, prospecting and drilling or similar operations.

III.—*Local Educational Reserves*: These include small areas of local country containing representatives of local flora, which are reserved for educational purposes for the benefit of schools and colleges.

NATIONAL PARKS

Uncontrolled destruction of wild life has been going on in many countries all over the world, and as a result of this natural fauna has dwindled and many species have become extinct. In countries of Western Europe like England the process of death and destruction has reached such limits that the sight of a wild bird or animal is regarded as an event of such importance, that it inspires many lovers of nature to write letters for publication in *Times*, saying that they heard a a cuckoo at such and such a place. With the modern means of rapid transport such as motor car, jeep, and aeroplane, the whole world is becoming so speedily opened up to travellers, tourists and traders, and with the increasing population, so much uncultivated land is coming under the settler's plough, that the need for the preservation of fauna in national parks and reserves is being increasingly felt.

National parks and reserves were originally established in the United States of America. There are 26 National Parks in America covering a total area of 1,500 square miles. The first National Park to be established in the U.S.A. was the Yellowstone National Park in 1872. Forests in the National Parks are preserved for their beauty and scientific value. In the Sequoia National Park in California grow tree groves of the worlds oldest and biggest trees, the Sequoia, which are 3,000 to 4,000 years old with trunks up to 17 feet in diameter . In Mt. Mckinley National Park in Alaska there are extraordinary areas for the study of glacial action. In the Grand Canyon National Park of Arizona can be seen the most interesting examples of water erosion. Here the Colorado river has cut 19 canyons, of which the Grand Canyon is a mile deep, and is flanked by intricately carved and most gorgeously coloured rocks. In Saguaro National Park in Arizona can be seen segments of the oldest desert of the world with desert animal life and a large variety of cacti and other xerophytic plants. All these parks are wild life sanctuaries which provide shelter to animals like bears, bisons, deer, elk, moose, antelope and mountain sheep.

In 1940 the U.S. Bureau of Biological Survey was fused with the U.S. Fish and Wildlife Service, which concentrates mainly on vertebrates including game and fur-bearing animals. The refuges of these animals are of immense size, and are habitats artificially controlled or improved to accomodate or attract particular birds and mammals.

The lead of U.S.A. has been followed by other countries such as Canada, Australia, New Zealand, and the Union of South Africa In South Africa, the Sabi Game Reserve was founded in 1898, and in 1926 it was renamed as Kruger National Park. The Albert National Park in Belgian Congo was created mainly due to the efforts of an American naturalist Carl Akeley. Due to the creation of this sanctuary for wild animals the Gorilla has been saved from extinction. The Swiss National Park is about 62 square miles in area, and arrangements are provided in it for enabling the student and tourist to enjoy the more spectacular fauna and flora.

NATIONAL PARKS IN INDIA

In India the necessity of creating National Parks has found a tardy recognition. Dr. Baini Prasad has thus summarised information about National Parks in India:

"In 1934 a very great advance was made in the United Provinces through the great personal interest taken by the enlightened Governor of the Province, Sir Malcolm Hailey, as a result of which the National Parks Act of 1934 was passed. This Act provided for the establishment of National Parks and for the preservation of wild animal life or other objects of scientific interest and for incidental matters provided therein. As a result, the Hailey Park was demarcated as a National Park in the famous Patli Doon and the hill forests to the south of it consisting roughly of an area of 99.07 square miles. Under the Act the word 'animal' was defined as 'mammals, reptiles, or birds,' and it was an offence to kill, injure or disturb any animals or to take or destroy any eggs or nests of any birds in the park. The conditions under which the people were allowed to enter or reside in the park were laid down in the Act and were to be enforced by the forest department. In Assam certain areas had already been demarcated as game sanctuaries and more stringent action was being taken to preserve wild life which according to some reports had been reduced by almost 75% within recent years. Reference may also be made here to the Chamrajanagar Sanctuary of the Mysore State Forests which had been established with a view to offering complete immunity for animals and thereby making it possible for them to thrive without interference. Introduction of other animals not found in the area was to be attempted, and the sanctuary was to provide facilities for the scientific study of the life-histories of different indigenous species of game."

NATIONAL NATURE RESERVES

There is a clear need of establishing nature reserves within national parks. The principal purpose of such nature reserves, as given by the Wild Life Conservation Special Committee of England and Wales are as follows and are applicable to India also:

(a) "To conserve and manage, for the enjoyment and interest of visitors, and for the use of naturalists, students and teachers, sites of biological, physiographical and geological importance and characteristic stretches of the natural vegetation. Similar considerations would apply in a less degree to other areas which, though not so valuable on strictly scientific grounds, have just as much importance because of their general charm or because they contain objects of marked beauty—whether rocks, trees, or flowering plants.

(b) To establish breeding reserves for scientifically encouraging particular species or communities of species the preservation or wider spread of which within the park it is desired to promote. In such reserves public access would have to be more or less restricted.

(c) To set aside areas so managed as to attract rare, interesting and beautiful species not at present living in the park or its surroundings."

The authorities who are made responsible for the management of the reserves should keep close touch with University or educational centres, as well as main local natural history societies. A need would also arise of providing small handbooks on nature reserves, explaining with the aid of maps, photographs, and sketches the scientific significance of the reserve.

LOCAL EDUCATIONAL RESERVES

Lack of field training for teachers as well as students, is one of the most serious deficiencies in current biological education in India. Without field training or facilities for nature study, teaching of Botany or Zoology tend to become lifeless and warped. Thus there is need of local educational reserves for all colleges where biological sciences are taught. The local Educational Reserve is the counterpart of the college museum and the laboratory. These reserves would open a vast and a stimulating field of knowledge in a discipline which trains such mental attributes as acute power of observation, patience, concentration, detailed ordering of thought, and the appreciation of form and colour. Visits to these reserves under proper guidance would provide a liberal education to the students in one of the most stimulating and formative fields of thought. These are gains which can not be quantified in terms of money. A beginning in this direction has been made in Delhi Province, where the local government has placed an area of 20 acres on the 'Ridge' at the disposal of the University of Delhi, Department of Botany. This piece of land will be enclosed with barbed wire, representative trees and shrubs would be labelled and efforts would be made to introduce other local plants also which can grow under these conditions.

NEED OF NEW POLICY

With the liquidation of the feudal order and the merger of states into unions, the problem of wild life preservation has acquired a new significance. Whatever may be the faults of princes and rajahs, it must be said to their credit that they preserved the wild animals and forests of their states rather well. With the growing demands of cultivators who want to save their crops from harmful animals, there is need of clear formulation of policy. There is immediate need of initial survey of all proposed National Parks Areas. While there is necessity of maintenance of good vegetational balance and preservation of rich flora and fauna in the National Park Areas, the general wild life policy must be such as will not prejudice the use of developed agricultural land. The interests of the cultivator and the lover of nature must be harmonised. The apprehensions of farmers that National Parks and Nature Reserves will develop into uncontrolled sanctuaries where pests and weeds will be allowed to flourish, and which will spread into surrounding agricultural lands must be allayed. The biologists must give lists of harmful and usefuls birds and animals. While the friends of the cultivator should be encourged in the National Parks, the enemies must be exterminated. The biologists should also give a finding whether campaigns should be started for the destruction of wild boars, porcupines, monkeys, bats and parrots who cause enormous damage to crops and gardens. Before any such campaigns are started, it should be ascertained whether wholesale destruction of certain birds or animals may not have harmful repercussion, elsewhere, on account of the upsetting of balance of power between various organisms. An action which *prima facie* may appear sensible and desirable may have far-reaching and most unpleasant and unforseen consequences fifty years hence. As the authors of the reports of 'The Wild Life Conservaion Special Committee' observe, "A conservation policy directed to maintaining any particular biological equilibrium entails constant vigilance and a fine-scale 'management' of a kind comparable to the most highly developed farming". The Special Committee further recommends the establishment of a National Biological Service, which should include not only systematists, but also others. As the Committee further observe. "Though the ability to recognise and name an organism is the first essential stage, it is by no means the last. The ecologist, the plant or animal physiologists, the geneticist, the student of behaviour, the soil scientist, the climatologists and the statistician each has his prominent place in the picture. But standing level with the biological sciences, though too often neglected in the context of nature preservation, are the geological and physiographical sciences; for it is from the nature and distribution of the rocks and from the configuration of the earth's crust that the natural beauty of scenery and its living carpet are derived".

The Committee further enumerates the functions of the proposed Biological Service as follows:-

"(a) The scientific and practical management and maintenance of the series of National Nature Reserves in such a way as to provide:-

(i) Reservoirs for the conservation of the main types of wild life (plant and animal species and communities) represented in the country;

(ii) Facilities for the conduct of fundamental and applied research and survey;

(iii) Certain educational facilities for students;

(iv) Facilities for the amateur naturalist and members of the public to observe and enjoy nature;

(b) The provision of advice and the conduct of any scientific work that may be required by the National Parks Commission in relation to National Parks and Conservation Areas;

(c) Making local representations on scientific questions affecting conservation (e.g. to local planning authorities and Advisory Committees) and the watching of sites of special scientific importance which are not National Reserves, with the object of interesting their owners in a sound conservation policy;

(d) The central representation of informed biological opinion in relation, e.g., to protective legislation and the effects of pest control;

(e) The biological survey of National Reserves and the conduct of wider surveys, distributional recording, etc., with the ultimate aim of carrying out a thorough survey of wild life throughout the country as a continuing process, since plants and animal communties are essentially dynamic organisations subject to rapid and far-reaching changes;

(f) The conduct of, as well as the provision of facilities for, long term and short term field research;

(g) The conduct of such research on problems affecting forestry, agriculture, drainage, water-supply, erosion and coastal accretion, landscape and amenity conservation, etc. as the respective authorities may consider could with advantage be undertaken by the Biological Service;

(h) The maintenance of a central bureau of information for the digesting and indexing of all data relevant to the work of the Service whether derived from that work or from external sources:

(k) The maintenance of liaision with the central and local authorities concerned, with other reserve-holding bodies, with academic and other centres of research, and with the public".

NEED OF A CENTRAL BIOLOGICAL SERVICE FOR INDIA

In India also there is need of a Central Biological Service under the Ministry of Agriculture of the Government of India to deal with problems relating to conservation of nature, national parks and fisheries. Dr. Baini Prasad, who realised the importance of this problem is also of the same opinion. He observes, "The multifarious problems involved cannot be tackled properly until the all-India nature of the problem is realised and a separate department of the Central Government made responsible for this work. While leaving the local problems to various provincial Governments and Native States, a central department should be responsible for dealing with the policy of conservation of wild life for India as a whole".

The Central Biological Service may be co-ordinated with the Indian Forest Service, and may form a part of it. It should be staffed by scientists with appropriate qualifications, and should be equipped for survey and research in the field and in the laboratory, with the object of determining the distribution, ecology, genetics, general structure and behaviour of natural populations and physical conditions in which they live. The serves will be used by the scientists of the Central Biological Service as field laboratories for the study of wild life and its control, and to elucidate the causes which promote or modify the maintenance of the living equilibrium in such areas. In conjunction with the Universities fundamental research on problems of nature conservation can also be fostered. Best results will, however, be obtained if free flow of staff between the universities and the Central Biological Service is allowed. This will be of mutual advantage. The scientific workers in universities will benefit by field experience, while the field workers of the Central Biological Service will maintain contact with problems of fundamental research, and recent advances in research in biological sciences.

PROTECTIVE LEGISLATION

In January 1935, the Government of India convened an All-India Conference for the Preservation of Wild Life at Delhi, with a view to reviewing the position of fauna and flora as it existed at the time and considering generally problem of protection of the animals peculiar to India. The Conference prepared two lists of species, first of animals that were to be protected as completely as possible, and second of those which could only be hunted, killed or captured under a licence, in some cases subject to a bag limit. The Conference further laid stress on the establishment of wild life sanctuaries. It was further recommended that the duty of preserving of fauna should be assigned to forest departments in the areas under their charge, and the necessity of co-operation of police and magistracy was also urged.

A comprehensive protective legislation was enacted in 1933, in the Punjab Wild Birds, and Wild Animals Protection Act. All wild birds and animals were classified into three categories:—

(1) Wild birds and animals which are excluded from protection,

(2) Wild birds and animals which may be killed and captured without a license during a specified period,

(3) Wild birds and animals which may be killed or captured under a license, subject to a bag limit in some cases, during a certain period. Shooting of these is prohibited during the breeding season, which is the close season.

To administer the Act, a Game Warden was appointed for the provinces of the Punjab and Delhi. A Game Inspector was appointed in each district with a number of Game-Watchers. In addition, District Fauna Committees were established in each district with the Deputy Commissioner as Chairman for advising generally about the protection of fauna in their respective districts, and for making propaganda among the general public urging the necessity of preserving wild life. The District Fauna Committee of Delhi has done exceedingly useful work. Pictorial charts showing the close season and the birds and animal friends and foes of the cultivator were designed for wide circulation in schools, *panchayat-ghars* and police stations.

There is need of protective legislation on the lines of the Punjab Act of 1933 in other provinces also. Moreover the Act should be made more comprehensive and cognizance should be taken of the plant world too. Plants which are rare or striking, beautiful or odd should be scheduled for protection in areas where this is necessary. Rare plants like species of *Lycopodium, Ophioglossum,* and *Osmunda;* and other beautiful plants like *Orchids, Rhododendrons* and *Meconopsis* etc. which are liable to excessive collection by botanists and which are widely plundered and uprooted by 'pleasure' pickers should also be given protection. Their collection should be permitted only under proper control.

PLANT SANCTUARIES IN THE HIMALAYAS

Some of the Himalayan Valleys are in grave danger of losing their character on account of excessive grazing and growth of *Rumex.* Apart from other vegetation, the sheep and ponies which are taken to Alpine meadows above the tree line by graziers in the months of April and May, graze mainly on *Rumex.* A symbiotic relationship has developed between the sheep and *Rumex.* While the sheep feed on *Rumex,* in their turn they manure the pasture land with their droppings, which in turn further encourages extensive growth of *Rumex.* The result has been that more attractive, but less edible alpine plants are driven out by *Rumex,* which now covers big areas in Himalayan alpine valleys like that of Pindari Glacier. In the interest of tourist industry, it is very necessary that some of the beautiful alpine Himalayan valleys should be declared as plant sanctuaries; and not only collection of beautiful and rare plants should be controlled, but at the same time, the grazing of sheep and cattle should also be prohibited. This is necessary in the interest of not only tourist industry, but also for checking of soil erosion as well as botanical studies.

NATURE CONSERVATION AND SOIL EROSION

Nature conservation, and conservation of soil, forests, grass-land and water are intimately connected. Most changes in nature are slow, insidious, and not readily detectable. A change in the balance of power between small organisms in the soil, a slowly dropping water table; these are potent factors in the destruction of a countryside. What has to be done to conserve the soil and water resources so as to maintain or establish a series of varied and most delicately balanced conditions? This question is just as fundamental to agriculture, horticulture, forestry, game preservation fisheries etc. as it is to the management of the National Parks.

Soil erosion occurs as a result of removal of plant cover on account of deforestation by man, or by uncontrolled grazing by cattle and goats, or the utilisation of grass-lands for agriculture. To understand the disastrous result of soil erosion it is necessary to know what is soil.

Soil is more than mere disorganised rock material. It has been aptly described as a living organism. Apart from the soil particles, there are numerous bacteria, protozoa, diatoms, and other soil micro-organisms along with the decayed remains of plants which compose the soil. Leaves of trees bushes and herbs form a protective cover which acts as a sponge absorbing the run-off water. This water percolates through the humus layers to the minerals of the soil and accumulates in underground storage reservoirs, which give birth to numerous fresh-water streams. With the plant cover removed by the action of man and animals, the run-off discharge of water increases at an alarming rate. Dr. Gorrie has made observations on run-off data in the Pabbi Range, Jhelum district, and has found that in an area which is fairly covered with trees, the maximum run-off was less than 100 cusecs per square mile, while in the land, where persistent cattle and buffalo grazing has destroyed the cover, the run-off rose to 1,600 cusecs. Moreover, silt-laden water has a sealing effect on the pores of the soil and the amount of seepage is considerably reduced. The silt-laden water has also sand-papering action on the floor and sides of the channel. Valuable salts containing potassium, phosphorous, calcium and nitrogen are also lost as well as micro-organisms, which play an important part in the proper development and functioning of the roots.

When more surface soil is washed away, clefts appear in the top soil, and gullies are formed. During monsoons the rain water rapidly flows away, flooding the countryside. Thus water conservation becomes a serious problem, water level falls and the country in general becomes dry and barren. The land becomes useless for agriculture and does not even produce enough grass. The repercussions of all these changes on wild life are serious. With the disappearance of grass-lands, forests and fresh water streams, wild life also begins to disappear. The erosion problem of the Siwaliks is a case in instance.

Records which are available show that in the middle of the nineteenth century, these ranges were covered with thick vegetaion, which harboured a number of wild animals. These forests were protected by the feudal landlords and Rajahs for *shikar*. In the conditions which prevailed in the last phases of the Sikh rule and the early days of British occupation of the Punjab, the hillmen further encroached upon the forests. Grazing of goats and cattle and the cutting of trees continued unchecked for a long time. In the early nineteenth century the *Chos*, which are now torrential monsoon rivers, were perennial fresh water streams which furnished valuable irrigation in the sub-montane area of Hoshiarpur. With the disappearance of the plant cover, these perennial fresh water streams become torrential monsoon rivers, which wash away large quantities of soil and have covered with sand the fields which were once fertile. The forest-covered Siwaliks have degenerated into bare hillocks which are not capable of producing enough for even the starving population of human beings, goats or cattle; much less of providing food and shelter for wild life.

What remedies should be adopted to check soil erosion? Closure to grazing and its substitution by grass-cutting and stall-feeding, replacement of goats by sheep which are less destructive, have been suggested. Agricultural practice in areas in the Himalayan and sub-montane areas also need to be modified. Terracing, bunding, contour ridging, contour furrowing, crop rotation and strip cropping also require attention. However, the sovereign remedy is re-afforestation, and "PLANT MORE TREES" should be our slogan for next decade.

A BIO-AESTHETIC PLAN

We are indebted to Professor Lancelot Hogben for the term "bio aesthetic planning" which may be defined as conscious planning of the flora and fauna with the object of beautifying the country. Bio-aesthetic planning embraces both the animal and plant sciences, Botany and Zoology, and may be further defined as planned ecology of living beings from the artistic and aesthetics points of view. It includes the aesthetic planting of ornamental flowering trees along city roads, in parks, public places and compounds of houses both in towns and villages, planting of trees of economic value which yield timber, fuel and fruit along roadside avenues of our national and provincial highways and district and canal roads, and on waste land in villages, and development of National Parks for the preservation of useful and harmless birds and animals, and creation of bird sanctuaries. The object of our bio-aesthetic plan for India is the encouragement of selected ornamental flowering trees in our towns and villages, protection of beautiful harmless birds like wild ducks, egrets, geese and *sarus* cranes by legal declaration of some of our big Jheels (lakes) as bird sanctuaries, and preservation of graceful animals, which are being ruthlessly exterminated, such as black-buck, blue bulls, sambhars and spotted deer in zoological gardens in the vicinity of our big towns and in National Parks.

A TREE PLANTATION PLAN

Just as we are planning the development of industrial and agricultural resources of our country we should also have a national plan for encouraging the growth of fruit, timber and ornamental trees. In drawing the plan we have to consider the choice of trees for each climatic zone of the country and also take into view the soil and water supply. We have also to clarify our ideas regarding the choice of trees for various purposes, e.g., planting road-side avenues, city roads, canal banks, public parks, platforms in railway stations and compounds of private houses. We have to assign ornamental flowering trees, timber trees and fruit trees to places where they can best fulfil their function. At present we see the irritating spectacle of fruit trees being grown indiscriminately in the compounds of houses and timber trees in public parks and city roads.

THE PLAN

In brief we may sum up our tree plantation plan for India as follows:-

1. Bio-aesthetic planting for compounds of private houses, dak bungalows, banks, hotels, universities, colleges, schools, public offices, town roads, public parks and should select trees with beautiful flowers and foliage to beautify them and to give pleasure to the people. Kachnar, pink cassia, erythrina, milletia, amaltas and gul mohur come under this category.

2. Roadside avenues of our national, provincial and district highways: The sole criteria for selection should be shade plus economic utility. For this purpose trees which yield timber or fruit and are also shady should be selected such as mahua, mango, tamarind, neem and sheesham.

3. Canal roads: We should plant all canal roads with fruit trees like mango, jaman, kathal, etc. The stones of varieties like langra dussehri, sufeda and fajri, yield excellent fruit trees which are better than the desi mango. There are thousands of miles of canal roads which can be planted with fruit trees thus adding a valuable source of vitamins to the deficient dietary of our people.

4. Village plantations: Fruit, timber and fuel are the main requirements of villagers. Fruit trees like mangoes, lemons, papaya,

kathal and sweet-limes are recommended for planting in the compounds of the houses of villagers, their phulwaris and along the bullock runs of their wells fitted with persian wheels. They should also be encouraged to plant bakain and mulberry trees in the compounds of their cattle sheds.

BIO-AESTHETIC PLANTING

Public places which belong to the community as a whole rather than individuals should claim preference in bio-aesthetic planting. Larger number of persons, especially those who are unable to afford private gardens of their own will thus be able to enjoy the sight of beautiful flowers. Public parks and squares, public roads, platforms of railway stations, compounds of hospitals, universities, colleges and schools, ancient historical buildings under the supervision of the Archaeological Department, compounds of courts, office buildings of municipalities and district boards, and dak bungalows of the Public Works Department, Canal Department and District Boards are places in towns which are susceptible of bio-aesthetic planning and should claim preference in our programme for the beautifying of our towns and cities. Proprietors of hotels and banks, and owners of new bungalows should also be encouraged and given all assistance in the planting of ornamental trees.

TOWN PLANNING AND BIO-AESTHETIC PLANTING

Town planning and bio-aesthetic planting go hand in hand. Orderly and planned planting of ornamental trees can be seen to its best effect in new towns with wide roads flanked by shady footpaths, well-laid-out public parks and squares, rather than in congested old towns with narrow crooked streets. Our old towns offer little scope for bio-aesthetic planting. Firstly they contain few open places suitable for planting and secondly their streets and roads are too narrow.

OUR OLD TOWNS

Town planning is a precondition of bioaesthetic planting. We have allowed our towns to develop without any plan or order. In our country *laissez faire* has really gone amock and the results have been most unfortunate. Ugly ill-ventilated houses joined together in monstrous piles along narrow, crooked lanes that is how our ancient towns like Old Delhi, Lucknow and Banaras appear to an outsider whose eyes are accustomed to western orderliness. An aerial view reveals them as pieces of a *jig-saw puzzle,* mixed up in a crazy pile and not a patch of green in these prison-like piles of masonary. These houses may have been suitable in mediaeval, insecure times when security was the guiding principle in our domestic architecture rather than ventilation, but at present they appear anachronisms and fossils of a social and economic order which disappeared long ago. In these old towns, and their bazars we see a reflection of our disorderly and undisciplined social and economic life. They may appear romantic to foreigners who come to our country in search of oriental mysticism and magic, but are certainly not fit for the growth of a healthy nation. It is time that we realize that we had enough of these smelly streets. The younger generation must be educated in a new mode of living. We must improve the environment which surrounds the individual in our towns.

A very pertinent question arises about the fate of these old towns. What should be done with these ancient insanitary slums? These old towns are in need of drastic surgery. We must decongest these old residential areas by compulsorily acquiring suitable central housing areas, and after demolishing the ugly houses we should develop parks and open places in the sites thus acquired. Improvement Trusts have done useful work at Cawnpore, Lucknow and Allahabad, but the rate of progress is snail-like, and painfully slow considering the tempo of modern life and requirements. In the parks thus made, bathing tanks should be constructed for the enjoyment of citizens in hot weather and incidentally for irrigating the trees and lawns.

The garden suburb should be our ideal in this hot country for vertical development is unsuitable considering the summer heat and flats are positively uncomfortable in hot months. Moreover the development of motor transport has greatly facilitated horizontal and peripheral development of towns. So far as possible the growth of these garden suburbia should be planned in a concentric manner, to economise fuel for motor vehicles.

NEW TOWNS

With the influx of refugee population from Western Pakistan into India, the problem of raising new townships in the vicinity of old towns has assumed great importance as well as urgency. The surplus refugee population is mainly urban and must be absorbed in the urban economy of India. Besides there is also a proposal to build a new capital for the East Punjab. So the problem arises, what should be our ideal in this new town development? The Garden City should be our ideal and the Welwyn Garden City in England, and the Model Town of Lahore provide an example which may be profitably followed in the development of new population centres. For our city of the future, Le Corbusier model with many-storeyed offices and factories linked with the garden suburbs by means of bioaesthetically planted roads, will be very suitable. People will work in the production hub of the city during daytime and will scatter again in the garden suburbs in the evening enjoying their life in healthy, quiet, noise-free and dust and smoke-free surroundings .

BATHING TANKS

Public bathing tanks should form an essential feature of these new towns. People can enjoy themselves in these tanks during summer and their waste water can be used for irrigating the public parks and gardens, which should be planted with ornamental flowering trees. Canals where available can also serve a useful purpose and also provide excellent opportunities for scenic planting and beautifying the towns.

ROAD PLAN AND TREE PLANTATION PLAN

For our towns we are not only in need of 'Road Plan' for traffic but also 'Tree Plantation Plans'. For every town of importance a 'Tree Plantation Plan' should be drawn and rigidly adhered to. For new roads it is comparatively easy to plan plantation of unfamiliar flowering tree, and it is the old roads which present a problem. The only practical solution is replacement of dead, decaying and old trees according to a plan. Once a plan is made, it should be rigidly followed not only in new plantations but also in replacements.

CHOICE OF TREES

While shade and economic utility should be the criteria for selecting trees for national, provincial and district roads passing through the countryside, different types of trees are required for town roads. For road-side avenues in towns and cities, shade and beauty are the sole criteria which we should consider while selecting trees. Unfortunately, there are very few trees which combine shade with beauty of flowers, for the large majority of our flowering trees are deciduous. Where space available is limited and only one row of trees can be grown on each side of the road flowering trees like Gul-mohar, Amaltas, Jacaranda, Erythrina and Spathodea may be grown alternating with shade trees like *Eugenia operculata.* Choice should be restricted to one species only for each street. Very tall trees like Eucalyptus and Millingtonia, and trees with spreading crowns like Banyan, are unsuitable for town roads, for they interfere with electric wires. Medium-sized trees like *Eugenia operculata* and Pakur (*Ficus infectoria*) which are extensively grown in New Delhi, are ideal for shade while for beauty we have a large number of trees to choose from.

DOUBLE AVENUES FOR CITIES

Double avenues of trees are a necessity in big cities, where sufficiently wide roads are available. The outer row should be of shade-trees, and inner of ornamental flowering trees. The outer row should be composed of ever-green shade trees with dense foliage such as *Tamarindus indica, Polyalthia longifolia, Eugenia operculata, Putranjiva Roxburghii, Mimusops elengi, Ficus retusa, Melia Azadirachta* and *Ficus infectoria.* The function of the outer row is of shade only. These trees should be planted in pure avenues. The inner rows should be planted with ornamental flowering trees only. The outer rows of shade trees will provide shade for pedestrians on the footpaths and at the same time will furnish a green background for the pink, red, crimson and yellow flowers of the flowering trees.

SOME COLOUR SCHEMES

While most of the flowering trees look beautiful when planted in pure avenues, there are some species which flower at the same time and the colour of their flowers also harmonizes and hence appear more effective when planted together. Some of the flowering trees which flower in the same season grouped in schemes with due regard to colour harmony are recommended for planting along our town roads.

Yellow flowered *Cassia fistula* grown alternating with *Poinciana regia* provides a very striking colour scheme, the rich yellow colour of Amaltas flowers contrasting with the scarlet orange colour of Gul-Mohar flowers in the month of May when both the trees are flowering.

The three varieties of *Bauhinia variegata*, pink, white and purple-mauve, and light magenta *B. Krugi* grown alternating with each other are suitable for dust-free roads of residential areas. All these Bauhinias blossom in a leafless condition from middle of February to middle of March when they look like huge bouquets of pink, white, purple and light magenta flowers.

TREE PLANTING PLAN FOR NEW DELHI

The tree plantation plan of the modern city of New Delhi can serve as a model for many of our towns. When Sir Edwin Lutyens came to New Delhi, he asked for a list of trees which could grow here. Griessen of the Horticultural Department prepared a list of trees and tree-like shrubs that might be made use of in the planting of the New Capital at Delhi. Griessen planted the first laid out roads, but on account of unsatisfactory water supply most of the roads had to be replanted several times. Griessen retired in 1920 and was followed by Mustow who established the nursery at Jor Bagh opposite the Safdar Jung Tomb. Hence-forward all tree planting, and all that grows in New Delhi, owed its existence to Mustow. He afforested the ridge. He introduced the *Prosopis juliflora* from Mexico, and thus gave India a hardy tree which may even help to make Rajputana green. Generally road-side avenues were inter-planted; quick growers between the permanent and low growers. Most of that inter-planting has been cut out. Extensive use has been made of many of our flowering trees for brightening up the housing areas, squares and circuses. For road-side avenues *Eugenia operculata* with its light green leaves has been found to be the most suitable. It sheds its leaves in late February, and renews them in early March, after remaining leafless for only a few days. It has a compact semi-globose crown and its light green leaves appear very soothing to the eyes. Avenues of these beautiful ever green trees adorn the parks on both sides of the Kingsway and are also planted on many roads. Other successful road-side trees are *Kigelia pinnata, Pongamia glabra, Ficus retusa, Ficus infectoria, Celtis australis, Sterculia alata, Cassia fistula, Anthocephalus indicus, Piptadenia oudhensis, and Melia azadirachta.*

The secretariat and the Viceregal buildings are the nucleus of the lay-out of New Delhi and a number of of roads radiate out from them. The clipped bushes of *Diospyros cordifolia* in the lawns in front of the Government of India buildings look very attractive. The trees annually receive a light pruning treatment, the branches being cut at a certain distance above the ground. This leaves space for pedestrians to wander below, and the Pathan-type of hair-cut which the trees receive gives them a trim and smart appearance. The clumps of Jacarands at the corners of the two Secretariat buildings are a sight in the month of April.

Most of the circuses in the centre of road junctions are enlivened with clumps of flowering trees like Jacarandas, Amaltas, Gul-Mohars and Kachnar. Where space available is narrow, use has been made of shrubby climbers like the various species of Bougainvillaea and *Petraea volubilis.*

The squares in housing areas have been planted with all types of flowering trees. The Semals in Hastings Square with their flaming red flowers are a sight in the months of March and April. Purple and mauve Kachnars lend their grace to many squares, though they have a rough time at the hands of clerks and members of their families, who pillage their buds ruthlessly for preparing curry.

Flowering trees have also been planted at the edges in the compounds of bungalows which are maintained under the supervision of the Public Works Department. At the gateways Bottlebrush trees with pendulous branches are commonly grown. We also find trees of *Jacaranda mimosaefolia, Bauhinia variegata, B. purpurea, Erythrina indica, Grevillea robusta* and *Ochna squarrosa.* In the foreground extensive use has been made of ornamental shrubs and pink oleanders lend their gay note to many bungalows of the capital. Scented shrubs like *Murraya exotica* and *Cestrum nocturnum* exhale their perfume in many bungalows. No attempt has, however, been made to vary the planting scheme, and as a result all the bungalows look alike. By adopting different combinations of trees and by planting some of the flowering trees in pure avenues, New Delhi could have been made more colourful. Another defect from which the plantation scheme for compounds of New Delhi bungalows suffers is that fruit trees have been totally ignored, and too much emphasis has been laid on mere ornamentals. Plantation scheme of New Delhi can be very much improved, if fruit trees like grafted mangoes, citrus plants, figs, and papayas are also planted in the backyards thus achieving a compromise between beauty and utility.

PLANTATION PLAN FOR OUR HIGHWAYS

A plantation plan for our National, Provincial and District Board highways is urgently wanted. In drawing such a plan, climate of a place, its temperature, rainfall, soil and water-level should be carefully considered and suitable species selected.

AVOID MIXTURES

On account of indiscriminate planting and thoughtless replacements our roadside avenues have become very much mixed. It is very essential that mixtures of different species are avoided and we have pure avenues of a single species for long stretches. This will not only improve their appearance but also render their management more economic, re-plantation easier and will rationalize their exploitation for commercial purposes. If mahuas and neems are grown in pure avenues for miles, oil-crushing industry can be easily started in such districts. Due to growth in compact areas there will be saving in transport charges. Similarly furniture-making industry can be encouraged in Sub-Himalayan districts which specialize in sheesham, sal and teak. Tamarind fruit which now only serves as a staple diet of monkeys, can be profitably exported to Western Pakistan. Mahua flower can be used for the manufacture of power alcohol.

SHADE

The main function of a road-side avenue is shade. Hence those trees which are quick-growing and provide dense shade should be selected. The trees selected should provide shade not only at sides, but also in the centre of the road. From this point of view trees with an umbrella or sub-umbrella crown like neem, mahua, imli and am, are more suitable than trees with a linear, elongated crown like teak, eucalyptus and millingtonia. If these trees provide shade, and also yield valuable timber or fruit, they are still more desirable. The trees should be planted 40 feet apart so that their crowns may develop freely. Where the road is more than 100 feet wide a double avenue of trees should be grown. A section of Lucknow-Rae Bareli Road has such a double avenue and the road is very shady and cool.

IDEAL VILLAGE PLANTATION

Village shamilat, the common land which is used for pasturing cattle, is ideal for village plantations. Old fallow land which has been out of cultivation for a long time can also be taken up for plantation purposes. The question is whether these plantations should be raised and managed by individual farmers or by the village panchayat. Plantation under the supervision of the panchayat and common ownership of the trees is an ideal solution but the difficulty lies in the lack of corporate sense in many villages. Usually we find that everyone's responsibility is no one's responsibility, and trees planted with great effort are grazed by cattle. So we have to adopt both the remedies. In a village where a panchayat is functioning successfully the plantation should be raised by the panchayat, which can also appoint village youngmen as guards for protecting the trees in the first two years.

In some villages it would be more feasible to partition the village wasteland into units 1 to 5 acres in area. These plots should be enclosed by kutcha-walls to give protection to young trees. Where water table is fairly high a kutcha-well may also be dug in the plot. Near the boundary wall thorny fuel trees like babul or mesquite (*Prosopis juliflora*) may be planted. In the middle area fruit trees like desi mango and kathal may be planted. The fruit trees may occupy 25 per cent. of the area and the remaining should be covered by fuel and timber trees.

CELEBRATING TREE PLANTING WEEKS

A "Land and Development Act" has been passed recently by the central legislature for the centrally administered areas of Delhi Province and Ajmer-Merwara. Under this Act a Development Commissioner will be appointed who, assisted by a Board, will prepare schemes on, among many other matters, the preservation and improvement of soil, prevention of soil erosion, development of horticulture and planting of forest trees, control and maintenance of tree growth, and planting or sowing of trees, shrubs and grasses for the purpose of afforesting uncultivable land. If practicable schemes are prepared and implemented with vigour, this piece of legislation will be of great use.

A country, however, can not be legislated into progress, and the mere passing of an Act does not provide a remedy for a vast problem. The ambitious tree planting scheme we have out-lined requires a nation-wide effort for its implementation. The importance of tree-planting must be brought home to the people. With this object in view a Tree Planting Week was celebrated in Delhi Province in July 1947 which was inaugurated by Pundit Jawahar Lal Nehru, Sardar Patel and Shri Rajagopalachari. The Week was a great success and all the Parks and Public Gardens of Delhi were planted with beautiful flowering trees whose flowers will lend their grace and beauty to our Capital six years hence. Our main object in celebrating this week was to focus the attention of our people to the national importance of tree planting. As Mahatma Gandhi commented in one of his evening post-prayer speeches: "The official who originated the idea of tree planting did not do it for fancy, nor was it meant for monied men. It began with them so that others would copy them and thus add to the wealth and rainfall of India". The idea of celebrating Tree Planting Weeks has caught the imagination of the people, and since last year such weeks were celebrated in many provinces. Planting of trees is regarded as an act of virtue in India, and as the trees we have planted grow up, they will remind our younger generation of the message of nineteenth century poet:—

"He that planteth a tree is the servant of God,
He provideth a kindness for many generations,
And faces that he hath not seen shall bless him".

SECTION OF ANTHROPOLOGY & ARCHAEOLOGY

SUGGESTIONS FOR IMPROVEMENT IN METHODS OF DATING

PRESIDENT: PROF. NIRMAL KUMAR BOSE, M.Sc.

Friends,

Please accept my gratefulness to you for the invitation to take the Chair in Anthropology and Archaeology in the present session. I know how it has been occupied by distinguished scientists in the past, and how unworthy and small I feel in comparison with them. They have given you the considered result of their researches, or shown you how to apply the products of scientific investigation to the solution of current problems of social life. I cannot pretend to do anything of the kind, nor do I feel competent to lay before you the finished products of careful and painstaking scientific investigation carried out in the field or the laboratory. All that I propose to do is to lay down for your consideration some problems connected with Archaeology as well as Anthropology, with suggestions as to how we can work together for their solution. It will be no more than an attempt to standardize methods, so that our sciences can come just a shade closer to the physical sciences in so far as discipline and exactness of method are concerned. It is thus a poor fare to which I shall invite you, and I should hasten to ask for your forgiveness at the very start on that account.

THE PROBLEM

In Anthropology, we have often to deal with a huge mass of undated facts. We have very often to arrange them according to their relative age, and then draw inferences about the course of evolution to which they have been subjected. From the time of Tylor, the Theory of Evolution has been employed for this purpose. Tylor as well as Otis Mason and others used it in their own time; and it has continued to be in use in one field or another to the present day. But there has been hardly any systematic attempt to devise some means in order to verify the findings of this method with the help of independent evidence.

The American School led by Boas, Wissler and Kroeber rejected the Theory for purposes of fixing either the relative or the absolute age of anthropological data. Ratzel, Graebner and Schmidt also replaced it on the Continent by what the latter has termed the 'Culture Historical Method in Ethnology'. Among these, as far as I know, Kroeber not only applied the Diffusion Method with great skill in unravelling the history of a primitive religion in Aboriginal America, but also tried to corroborate the findings by means of independent evidence obtained from excavation.

It is the purpose of the present paper to suggest a similar procedure with regard to the problem of dating, see how future research can be planned so that the validity of the proposed method can be reliably tested. The field of culture from which data will be drawn will be that of Indian

Architecture; and we can thus hope that workers in both Archaeology and Anthropology can co-operate with chances of being of real service to one another.

CURRENT METHODS OF DATING EMPLOYED IN INDIAN ARCHITECTURE

Indian Architecture has been studied from one point of view or another for a pretty long time. The work of Ram Raz, Cunningham or Kittoe was of a descriptive nature; while that of Fergusson, Vincent Smith, Manmohan Ganguli, Cousens, or Percy Brown, in more recent times, was systematic and historical. Havell, Coomarswamy and Kramrisch have laid comparatively more emphasis on interpretation rather than on historical reconstruction. There have also been many others like Ramaprasad Chanda, Rakhaldas Banerji or O. C. Gangoly who have dealt with one aspect or another of Indian architectural history; and we shall have occasion presently to deal with the methods employed by some of the workers mentioned above.

It is my pleasure here to refer to the work of Professor Stella Kramrisch as an outstanding example of what depths can be reached in the field of interpretation of the inner symbolism of architectural forms. It is only when others follow in her wake, and rewrite the history of the evolution of temples on the basis of her structural analysis and interpretation, that we shall be in a position to deal adequately with the methods of dating employed in that connection.

For the present, we shall therefore confine ourselves to the current methods employed, examine their validity and, if possible, suggest lines of work which may eventually lead to their modification and even improvement. For the sake of brevity, as well as for purposes of clearness, we shall limit ourselves to a consideration of two authors alone. This does not, of course, imply that the value of the work of others is lost upon us; only, that, for our present purposes, two would suffice to serve as representative examples. For others have practically followed one or the other of these two methods, the variation chiefly lying in the choice of the elements employed in the preparation of the evolutionary series.

Fergusson was a believer in unilinear evolution. Whatever may have been said to the contrary, his work still remains the foundation on which others have reared their later buildings, except in the case of a strikingly original and very rare departure as in the case of Professor Kramrisch. Believing in evolution, and in the contemporary belief that in the matter of evolution, the main trend was a growth from the simple to the complex, Fergusson, who had to deal with a very large mass of architectural data, relied on this theory for dating his temples, and subsequently for the reconstruction of the history of its development in India and elsewhere.

There was however one point in Fergusson's method to which attention should be drawn. While analysing the component parts of a temple, Fergusson depended on structural features, and only occasionally on ornamental embellishments. By noting where these features lay in the scale of classification, whether near the simple end or the complex end, he tried to assign a date to it in the relative chronological scale. For purposes of absolute chronology, he had naturally to depend on inscribed temples, of which it was possible to fix the date on the basis of independent evidence.

But his reliance on the validity of chronometry established by means of the Theory of Evolution was so great that he rejected the latter, when the two were at variance. Let us now illustrate his method by suitable quotations from his *History of Indian and Eastern Architecture.* We are told in Vol. II of the 1910 edition of that book:

> We have thus, as yet, but little help from historical sources. It is true that the dates of two of its temples have been approximately ascertained. The great one at Bhubaneswar is said to have been erected about A.D. 640 but possibly later—and that at Puri between A.D. 1080 and 1140, nearly the first and the last of the series. My impression is that in the later direction it can hardly be extended beyond the year 1260, but within these limits it seems possible to arrange the sequence of all these temples in the province without much difficulty, and to ascertain their dates with some degree of approximate certainty.—(p. 94).

> As above pointed out, almost all the ornaments on the facades of Buddhist temples are repetitions of themselves; but the Hindus do not seem to have adopted this system so early, and the extent to which it is carried is generally a fair test of the age of Hindu temples. In the great Pagoda there are eight copies of itself on each face, and in the Rajarani the system is carried so far as almost to obliterate the original form of the temple.—(p. 99).

> From the erection of the temples of Parasurameswar and others, perhaps in the 7th century, to that of Jagannath at Puri, A. D. 1100, the style steadily progresses without admixture of foreign elements, while the examples are so numerous that one might be found for every fifty years of the period, and we centuries that would be invaluable for application to other places and styles.—(p. 115).

Professor Rakhaldas Banerji was a reputed epigraphist. He had also some occasion to write on Indian Architecture and deal with its history. In a series of papers contributed to *The Modern Review* (December 1927, July 1928, January 1929, April 1930 and September 1930), he dealt with provincial variants of Fergusson's Northern or Indo-Aryan Type, described some new discoveries and tried to unravel the story of its origin and connection with temples belonging to the Gupta Period. In another paper published in the *Journal of the Bihar and Orissa Research Society,* (XV, pt. I & II., pp. 64-86), he described in detail the temples of Baud and Gandharadi. He also devoted a whole chapter to mediaeval Orissan temples in the second volume of his *History of Orissa* (ii, ch. XXIX). The method followed by Banerji was, on the whole, different from that employed by Fergusson.

His chief reliance was on epigraphy and on the character of the sculpture which served to decorate temples. Banerji had less faith in architectural or structural elements. Where he did use them at all, it was either for regional differentiation (*The Modern Review,* September 1930, pp. 251-2) or for purposes of chronology. But in the latter case, it was never pursued by him to yield more detailed results. For that, he relied more on evolutionary series based on changes in sculptural or epigraphical style. A few quotations will suffice to illustrate his method, as in the case of Fergusson.

> Though no inscriptions have been discovered in the temples of Deogadh, Bhumra and Nachna-Kuthara the dates of these temples can be accurately deduced from short inscriptions and mason's marks—(*The Modern Review,* January 1929, p. 54).

> In the case of the temple of Tigowa the use of animals on the capitals of pillars and pilasters in the verandah or porch proves that it can not be relegated to the Gupta period.—(*ibid.* p. 59).

Banerji dated the temple of Parasurameswar on epigraphic grounds to the 8th century A. D. (*History of Orissa,* ii, p. 341). He also wrote with regard to the temples of Gandharadi in the State of Baud:

> The ornamentation of the *Vimanas* and the *Jagamohanas* of the Gandharadi temples consists entirely of pilasters shaped as miniature temples and we miss the larger chaitya-windows of the Parasuramesvara. This total absence of a post-Gupta decorative *motif* certainly indicates a later date. The majority of writers on Indian Architecture are inclined to place the Parasuramesvara in the middle of the 8th century A. D. In that case the twin temples at Gandharadi should be dated close to that century, approximately fifty years later than the Parasuramesvara.—(*ibid.* ii, p. 347).

Banerji relied upon the exact nature of chaitya-windows used for ornamental purposes for determining the date of certain temples (*ibid.* ii, pp. 343-4). The only use he made of structural elements for dating was when he distinguished early from late temples by the presence of additional *pirha-deuls* in front of the *rekha.* He also had some use of the curvature of the *gandi* for chronometric purposes, as will be evident from the following quotation:

> The difference between the early *Sikhara* in Kalingan temples and its later developments, as is to be seen in the temple of Lingaraja or Krittivasa, Ananta Vasudeva, Brahmesvara and that of Jagannath at Puri, is that the older type of the *Sikhara* in the first group curves gradually but the later type takes a more pronounced curve near the top.—(*ibid.* ii, p. 336).

You will thus see how temples were assigned dates when they were without dates. Theoretically, this means a dependence upon the Method of Seriation. But then such a series has to be checked up from time to time, and its value re-assessed as new discoveries are made by means of which the date of individual members of the series can be more reliably ascertained.

The total number of temples in Orissa can be counted by the hundred while the total number of temples of which the lower limit of origin is correctly known through inscriptions would hardly reach two dozens. My friend, Pandit Vinayak Mishra tried to make up a very rough list for me, which I shall now proceed to present to you.

MIDNAPORE DIST. —Gaganesvara—15th cent.
CUTTACK DIST. —Gopinathpur—15th cent.
PURI DISTRICT. —Brahmesvara—11th cent.
—Kedaresvara—12th cent.
—Ramesvara—12th cent.
—Parasuramesvara—8th cent.
—Ananta Vasudeva—13th cent.
—Patalesvara—12th cent.
—Jhadesvara—12th cent.
—Lingaraja—11th cent.
—Jagannath—12th cent.
—Konarak—13th cent.

GANJAM DIST. —Mahendragiri—11th cent.
—Mokhalingam—(many inscriptions) 12th to 15th cent.

NAYAGARH —Govindapur Inscription of the 9th cent.; the temple being of later date.

BARAMBA —Sinhanath—14th cent. The temple is however earlier than the inscription.

From the above list, the reader will be able to realize how meagre is our data for preparing a reliable series for chronometric purposes. There is a large gap between the 8th and the 11th centuries, and this was undoubtedly one of the most formative periods of temple-building in Orissa.

If we then depend on the unilinear theory of evolution, and have such poor means of checking its results, our historical reconstruction loses much of its dependable character. From anthropological evidence we know that different elements of culture do not have the same rate of diffusion. They display different ranges of variability at the same point of time, and also variable rates of differentiation and of secondary elaboration in course of time. Thus, for example, in temples, ornamental elements may have one set of evolutionary values, while structural elements, like the manner of increasing the height of a temple, the way in which the curvature of the *gandi* is modified, or the particular technique employed to lighten the load on walls by having acutely pointed corbelled arches over the lintel and then tying together opposite walls by means of various devices—all these may have completely other rates of change. Moreover, provincial genius may also be responsible for certain modifications of ornament, just as a substitution of one building material by another may bring about consequent alterations in form as well as in ornamentation.

If we use any or some of these elements together for purposes of preparing our scale of reference for purposes of dating, then due allowance must be made for all the factors which reduce the chronometric worth of our scale. If we lump together the whole of India, or choose such elements alone as partake of the character of secondary elaboration, and do not feel confident enough to prepare a scale of evolution on the basis of structural elements, then we do an injustice to the very subject of our study. And if there be no means, or very poor means of verification of our findings from independent sources, then our entire reconstruction of evolutionary history loses very much in value, and we also lay ourselves open to the charge of begging the question.

I have tried in my own little way to study space-variations of Fergusson's Northern or Indo-Aryan Order, and then employed the Distribution Method to re-arrange the elements in order of time, and I shall forthwith present you with a broad outline of the results of those endeavours.

Let us begin with the north.

THE HIMALAYAN REGION

The temples of Kashmir can be left out of account for they constitute a separate Order by themselves. Of the temples present in the East Punjab, the more well-known sites are in Kangra, Baijnath, Nurpur, Masrur, Bajaura, Chamba and Brahmaur. These are mostly of the Rekha Order. There are Pirha temples in Chamba, Mandi and other places, while one Khakhara temple occurs in Jageswar in the Almorah Dist. in U. P.

The Rekha temples in this region can be classified in the following manner. The complex ground-plan of the Nurpur temple can be left out for the present; it is enough to say that the ground-plan of the rest is formed by a square. The other signficant features are here dealt with. Most of the temples are *pancha-ratha,* the *bada* having three elements. In Chamba, the frontal *raha* is highly projected. At Bajaura, this is repeated on all the four sides, with the result that the temple seems to be strengthened by buttress-like elements on all sides. But that is a singular example, the rest having the exaggerated projection confined to the front only. The *bhumi-amlas* in the *kanika* are almost everywhere right-angled instead of being segments of a circle. Only Bajaura and a shrine at Masrur have circular *bhumi-amlas.* In the temples of Chamba, as well as elsewhere, the *amla* is adorned with a flat band running round the middle. This divides the *amla* into two parts, as the equator does the earth. In the temple of Baijnath, there is a second, smaller *amla,* surmounting the main one, but this is a rare feature in the Himalayan region. The *khapuri* is absent. An object resembling a small ornate pillar, with an *amla* carved upon it, takes the place of the *kalasa.*

In most of these Himalayan temples, there is a small vestibule in front of the entrance, its sides being flanked by pilasters, which do not attain the full-fledged character of pillars. Attendant *pirha* structures are generally absent. Baijnath has a regular *jagamohana* in front, at the corners of which are attached four small *rekha* structures as in the *jagamohana* of Vaital in Bhubaneswar.

When we come to the details of the mouldings, we find that although the *pabhaga* in Baijnath is formed of five elements, the *kumbha* is not present anywhere; its place having been taken by the *noli.* The appearance of the *khura* is of the Parasuramesvara type, instead of the type associated with Lingaraja or Konarak.

RAJPUTANA

Rajputana is rich in examples of the Rekha Order; but many of them are known to belong to a period when the Mughal emperors sat on the throne of Delhi. We shall leave these later ones out of our present consideration and describe only such examples as partake more closely of the character of Rekha temples elsewhere.

Osian in Jodhpur is a site of very great importance, and so are some of the sites in the Udaipur State.. Osian has temples belonging to both the [illegible]kha and the Pirha Order, and one example of what might come under the

Khakhara Order. All, except the last-mentioned one, have square ground-plans; and the *bada* consists of three elements *viz.* the *pada, jangha* and the *baranda.*

Many of the temples of Osian are *pancha-ratha.* A curious feature present is that the *anuratha* also is divided into several *bhumis* like the *kanika* by means of *bhumi-amlas.* The latter are right-angled, instead of circular. The *raha* is decorated with chaitya-window designs. The *bisama* is left undecorated, though it is also divided into *pagas* like the *gandi.* There is only one *amalaka* at Osian, but examples elsewhere have another capping the principal one, as in the case of Chitor. There is curious feature in the temple of Jagadeesh at Udaipur. This consists of the fact that instead of the *bhumi-amlas* in the *kanika,* we find a series of *kumbhas* arranged one on top of another.

The vestibule in front, which we saw in the Himalayas, attains here a greater degree of independence. It takes the form of a small porch in front, its roof being supported by two pillars. It is capped by a short sloping roof or *chhajja.*

Where the *jagamohana* is elaborate, it is a pillared rectangular hall adorned at the sides by stone-benches having back-rests. These are known as *kakshasanas* in Gujarat. We shall see later on how the *kakshasanas* attain great elaboration and importance in Central India. To the east they extend as far as Rohtasgarh in Bihar, where it is found in one solitary temple.

The number of mouldings in the *pabhaga* of temples in Osian is generally three; and, as in the Himalayas, the *noli* takes the place of the *kumbha,* while the *khura* is of the same character as in the Parasuramesvara in Bhubaneswar.

Besides Osian, we come across some miniature *rekha* temples in the courtyard of the Arhai-din-ka-jhopra at Ajmer. These display a remarkable resemblance with similar temples described in the next section in connection with Central India.

CENTRAL INDIA

Not having any personal knowledge of the temples of Gujarat and of the western portion of Central India, I would chiefly confine myself to Bundelkhand, and more particularly to the Khajraho group of temples.

There, as well as in the neighbourhood of Ujjain and at Ajmer, referred to above, we meet with small shrines which were probably donated by people who had not the means of building larger structures. These attain the height of no more than three or four feet; but they are very useful and instructive from our point of view. The *bada* is *tri-anga,* the temple itself frequently *pancha-ratha.* The *raha* has a series of chaitya-window designs carved upon it. It also ends in an acute point, which often projects beyond the *bisama* and comes into contact with the *amla.* Supplementary, and smaller *amlas* are present on the top of the main *amalaka.* There is a vestibule in front of the shrine, as in the Himalayas, but it does not attain the development that we noticed in Osian.

In the famous group present in Khajraho, the temples are almost uniformly situated on a high sub-basement. A new feature in connection with the ground-plan is that there is a path for circumambulation round the *garbha*. *Kakshasanas* mark both the *rekha* and the *bhadra,* which belong to the modified Pirha Order.

The *pabhaga* in small shrines consists of three elements, the place of the *kumbha* being taken by the *noli.* In the elaborateness which characterizes the Khajraho group, the *jangha* is broken up into not merely three, but occasionally five parts, which means that instead of one *tala* and one *upar jangha,* we have three *janghas* separated by two *bandhanas.*

Ruins of a Rekha temple of fairly large dimensions exist at Sanchi, but as the *amalaka* and the *beki* alone are present, it is not possible to find out what the rest was like. There is one point however to be noted in connection with the *amalaka.* It had no band in the middle, as in the Himalayas.

UNITED PROVINCES

The group of temples that we find in the U. P. Himalayas is more or less, similar to the temples of the Eastern Punjab.

The plains of the Ganges and its tributaries were, in all probability, once enriched by beautiful temples. But the country was ravaged by people hostile to idolatrous worship in such a manner that hardly anything ancient remains except in the form of amorphous ruins. One small site like that exists at the edge of the plateau above Vindhyachal town in the district of Mirzapore. There we find a small *amla,* which probably capped a temple between twenty and thirty feet high. Ruins of a *khapuri* are also present, and it is decorated with ribs after the style of the *khapuris* in Khajraho in Central India. Another noticeable feature in the United Provinces, as revealed by the votive shrines discovered here and there in different districts, and illustrated by examples in the museum at Sarnath, is that the *raha-paga* extended upwards to an acute point which comes into contact with the *amalaka* on the top. In some examples it touches the *amalaka* at the base while in the Rajputana or Central Indian examples, it comes up to the middle. But for want of any temple of full-grown size, we do not know if this was really a general, provincial characteristic, or just an accidental feature associated with stray temples of small dimensions.

In these U. P. miniatures, we also come across a well-projected frontal *raha,* in the same style as we found in the Punjab Himalayas and in Central India. For want of evidence, it is not possible to say anything about the details of the *pabhaga.*

BIHAR AND WEST BENGAL

The district of Manbhum is rich in architectural remains. Gaya has also some very important examples, Ranchi has one of great interest; while quite a number of modified Rekha temples are present in the neighbouring districts of Burdwan, Birbhum and Bankura in West Bengal.

The temples of Telkupi, Para, Charra in Manbhum, which were built often plain, the *raha* nowhere stretching beyond the *bisama*. The *khapuri* is generally not present. But in the temple of Khakparta in Ranchi District, there is a small flattish one crowning the *amalaka*.

In the District of Gaya there are Rekha temples at Umga, Deo and Koch beside the famous temple of Buddha Gaya, which has certain peculiarities which mark it off from temples belonging to the orthodox Rekha Order. The architectural elements of the rest have not however been analysed properly, and so they can be left out of consideration for the present.

West Bengal and Manbhum possess a type of brick-built temple which is evidently related to the Rekha. Similar examples are present near Banpur in the Puri district as well as in Ranipur-Jharial in the Patna State in Orissa. We need not however concern ourselves for the present with this variant of the Rekha.

SOUTHERN DECCAN

Away to the south-west of the Deccan plateau, there is a group of *rekha* temples at Aiholi, Pattadakkal, Badami and Hangal, which would amply repay detailed study from the architectural point of view.

Some of these temples stand on a high sub-basement, others on the ground. They have *badas* consisting of three elements, and the *kanti* separating the *bada* from the *gandi* is deep-set, *i.e.*, its set-back is greater than in the case of the temples of a province like Orissa. The *gandi* as well as the ground-plan is *tri-ratha*, and the *bhumi-amlas* right-angled. The *bisama* is plain and slab-like; the *raha-paga* ends in a point in its neighbourhood. The apex of the *raha* does not however meet the *amla* at any point. The *amalaka* is single; it is like a slightly flattened spheroid in one case, and more so in others.

The frontal *raha* has a slightly greater projection than the rest. It is rarely as pronounced as in the case of the Markandyesvara in Bhubaneswar, but generally reminds one rather of the *rahas* of the Himalayan temples.

The *pabhaga* is of two or more mouldings; the place of the *kumbha* of Orissa being taken by the *noli*.

Where a *jagamohana* exists, it is rectangular and its roof is supported by a number of pillars. The ground-plan of the Durga temple at Aiholi is of a different kind from what is usually associated with Rekha temples. It is apsidal, and there is a path for circumambulation round the *garbha*.

More temples of the Rekha Order exist in the neighbouring country as near Alampur at the junction of the Kistna and the Tungabhadra in Hyderabad State; but their architectural details are very inadequately known.

MADRAS PRESIDENCY

Some Rekha temples exist in the north-eastern part of the Madras Presidency as at Mokhalingam or Saripalli. They will however be treated along with the temples of Orissa in the following section, with which they bear considerable measure of relationship.

ORISSA

A tentative classification of the temples of Orissa was published by me in

1932 in the *Canons of Orissan Architecture*. In the Appendix A of that book, a description of the characteristics of temples having three elements in their *bada* was also undertaken; and it need not therefore be repeated here. We can proceed straightaway to a study of the distribution of particular architectural elements, and see to what it leads us in the end.

The megascopic elements which have value for distributional purposes are:

1. *Bada* having three elements.
2. *Bada* having more than three elements.
3. *Raha* projects beyond the *beki* and ends in a point.
4. *Pabhaga* formed of *khura-noli-basanta.*
5. *Pabhaga* consists of *khura-kumbha* and other elements.
6. Presence of the *kakshasana.*
7. Temple placed on high sub-basement.
8. Temple without *jagamohana.*
9. Temple has *jagamohana* of rectangular type with pillars.
10. *Jagamohana* of the Pirha Order.

Without inflicting a series of maps upon you, I should prefer to describe in brief how the distribution shapes itself, and what relationships are consequently revealed thereby.

(*a*) The *tri-anga bada,* in which the pabhaga has a *khura-noli-basanta,* is of very wide extent, covering practically the whole of India from the north to the south and from the east to the west. In comparison, *panchanga* or *saptanga badas* are restricted to Orissa and its neighbourhood and to Khajraho and its neighbourhood.

From similar phenomena in Anthropology, we may infer that the earlier form is *tri-anga;* this having been subjected to different modifications in later times in the east and the central portion of India.

(*b*) The acute projection of the *raha* beyond the plane of the *bisama,* either to touch or not touch the *amalaka* is confined to Raj-putana, Central India as far as Khajraho in the east. It reaches down through Malwa to the south as far as the Bijapur district. It is therefore a western feature which did not affect Orissa or the eastern portion of the Madras Presidency. The double *amalaka* also seems to be a middle-Indian feature, extending towards the north and west, and having hardly any representatives in the east. The only two examples which do occur are at Mokhalingam, where the *amlas* are both of equal dimension, and in a small village across the Mahanadi at Baramba. The *kakshasana* is a slightly more restricted feature, present in Rajputana, Central India, and throwing out only one example in the fort of Rohtasgarh in Bihar, and one in Hangal in Dharwar in the south.

(*c*) *Bhumi-amlas* which have a right-angled appearance, are distributed widely, while those which are segments of a circle have a smaller geographical area. The former is, by analogy from

Cultural Anthropology, the older of the two. Right-angled *bhumi-amlas* are present in the Himalayas, at Osian and in Bijapur, as well as in Orissa and in the district of Bankura in West Bengal.

If we assume that these elements had approximately similar rates of diffusion and elaboration, then it might be inferred that the evolution to which Rekha temples were subjected was marked by the following features.

(1) Originally its *bada* was *tri-anga*. Later on, as the height of the temple was increased, in Orissa, it was replaced by *panchanga bada,* and still further elaboration took place in Khajraho.

(2) Probably, the *gandi* was also *triratha* in the beginning. But with increasing breadth and increasing height, the flat walls were variegated by further treatment to yield more and more *pagas.*

The *bhumi-amla* was right-angled; in later times, and in some provinces, it was replaced by segments of circles. This was in accompaniment with the softening down of the lines all over the temple. But where the plain, rigid, simple character of the temple was maintained, as in the Himalayan region, the right-angled character persisted till later times.

(3) The *pabhaga* consisted of three elements, of which the middle one was a *noli.* In Orissa, the *khura* was not increased very much in height, but the *noli* was replaced by a *kumbha.* Elsewhere, with increase in the height of the temple, the character of the *khura* became more and more elongated. This means that Orissan artists reshaped their mouldings in one way, and those of say Rajputana or Khajraho in another, in order to accomodate themselves to the growing height of the temple itself. The temple of Sirpur, which is known on epigraphic grounds to belong to the 7th century A.D. has a *pabhaga* consisting of three elements, the second one of which is a *kumbha.* This goes against the conclusion reached above.

(4) The *kakshasana,* the double *amalaka* and the sub-basement for seating the temple were probably later local developments; for we have seen how they are also of restricted spatial distribution. Two of these features were perhaps intended to keep pace with the growth in height.

(5) As the height increased, the flatness of the *pagas* became a disturbing feature. In Central India as well as in Rajputana, this was made up by adding *sikhara* after *sikhara* which sprang from the base of the *gandi.* But Orissa followed a different device. Not that it did not add ornamental *sikharas*; but she tried to retain the flatness of the *pagas,* only she added to their number. And, in order to relieve the character of monotony, Orissan artists decorated the *paga* surfaces with designs which were not in very high relief. Even in the temple of Lingaraja, where *sikharas* adorn the *anuratha,* they never interfere with the smooth upward movement of the curvilinear *sikhara.* They add to its grace, and by their presence keep time with the upward growth. In the temples of Rajputana, and if I am allowed to venture an opinion, even in Khajraho, the extravagant use of *sikharas* introduces an almost vulgar strain in the movement, on account of their ex-

aggerated separateness from the main body of the temple. *i.e.*, their independence from the prevailing plane from and on which they find their being.

Khajraho tried to counteract this feeling by a corresponding accentuation of horizontal lines at the base.

These are thus stray milestones that we discover by a reliance upon the Distribution Method in the evolution of Rekha temples in different provinces of India. One important point emerges, *viz.* that evolution has been multilinear instead of uni-linear. The moral is, that a scale set up in one province loses much of its value for purposes of dating in another.

You must have observed how we have so far depended on the megascopic character of temples. When we compare the results thus obtained, with those from another series built up on the basis of epigraphy, the results are found to correspond fairly well. But then we should never forget that, in Orissa at least, the number of such dated temples is very small and there are large gaps which can hardly be bridged. My point is that only when workers in different portions of India create one series on the basis of dated temples, and another by a reliance upon the Distribution Method, it will be possible for us to check the validity of the latter method itself. From the co-ordinated findings of these two, we shall then be in a position to check how far the Evolution Theory itself is dependable for our purposes. Fergusson and others took many things for granted while employing the evolution theory for chronometric purposes. It is our duty now to improve upon what they did, and fashion a tool by means of which undated data can be chronologically arranged with a greater amount of certainty. We do not want to rely solely upon one single method; but want also to devise means whereby the findings of one can be corroborated by the findings of another. We want to introduce something analogous to control experiments in History and Anthropology.

MEGASCOPIC AND METRICAL METHODS IN ARCHITECTURAL ANALYSIS

There is one more point that I should like to place before you before closing the address. I have already drawn your attention to the fact that we have so far depended almost wholly upon megascopic characters. But they are a poor substitute for characters which can be subjected to measurement.

After having visited most of the provinces where Rekha temples occur, and once more having come back to my starting point in Orissa, I began, in 1938, to subject the temples to measurement in terms of the rules laid down in the canonical books dealing with architecture. The results were often of an indifferent quality; because, instead of being able to use a theodolite which Manomohan Ganguli did in Orissa for his book entitled *Orissa and her Remains* (1912), I had to remain satisfied with a box-sextant, an artificial horizon and a measuring tape. To this later on was added an Abney's hand-level. As the work had all to be done alone, and often in haste, because of personal difficulties, they were certainly not of a high order. Yet, the imperfect analyses did serve to reveal certain features which were of a surprising nature.

Instead of burdening you with more details, I shall try to place in simple canonical formula the structural analysis of some of the temples belonging to Orissa and the northern portion of the Madras Presidency.

(1) *Somnath,* Puri Dist., Rathaka 2-1½-1½. Melana 3-1½ an. Garbha 16 Bada bahala 16 pabhaga 6.6 tala jangha 5.4 bandhana 2.2 upar jangha baranda 15.3 gandi and bisama 40.4 amla beki 10 khapuri 5.6 kalasa 5.5 proportion 1 : 5.3.

(2) *Mokhalingam.* Small shrine in the n.e. corner of the compound. Garbha 16 pabhaga 6'1, jangha 4'1 baranda 1 gandi plus bisama 50 beki 3 amla 3 khapuri 4 kalasa 6'5 kalasaghadi 2. Proportion 1 : 4'4.

(3) *Somesvara,* Mokhalingam.Garbha 16 pabhaga 6'3 jangha 6'7 baranda 9'3 kanti 0'8 gandi and bisama 38 2 beki 1 amla 5 kalasa 4 total 67'3. Proportion 1 : 4'2.

(4) *Gokarnesvara,* Mahendragiri. Garbha 16 pabhaga 5'5 jangha 11'3 baranda 3'3 gandi 27'6 mastaka 10'9 total 58'6. Proportion 1 : 3'66.

(5) *Parasuramesvara,* Bhubaneswar. Garbha 16 bada bahala 16 pabhaga 6'9 jangha 13'2 barandi plus kanti 2 gandi 32'7 beki-amla-khapuri 8'8 kalasa 4'02 total 63'6. Proportion 1 : 3'97.

(6) *Uttaresvara,* Bhubaneswar. Garbha 16 bada bahala 13'5 pabhaga 6'3 jangha 10'8 baranda 2'4 gandi 33 beki 4 amla 2(?) khapuri 4 kalasa 5 total 62'5. Proportion 1 : 3'9.

(7) *Siddhesvara,* Bhubaneswar. Garbha 16 bada bahala 13'4 pabhaga 6'4 tala jangha 5,5 bandhana 1'93 upar jangha 5'6 baranda 6'7 gandi 40'7 beki-amla-khapuri 9'1 kalasa 6'2 total 75'93. Proportion 1 : 4'7.

(8) *Muktesvara,* Bhubaneswar. Garbha 16 bada bahala 11 pabhaga 5'94 jangha 12 baranda 2'15 kanti 1'14 gandi 34'2 beki-amla-khapuri 6'75 kalasa (two in number) 7'85 total 62'18. Proportion 1 : 3'88.

(9) *Alabukesvara,* Bhubaneswar. Garbha 16 bada bahala 12'8 pabhaga 6'7 tala jangha 6'1 bandhana 2'1 upar jangha 5'3 baranda 6'7 gandi 37'8 beki-amla-khapuri 12 kalasa 2'8 total 76'7. Proportion 1 : 4'8.

(10) *Brahmesvara,* Bhubaneswar. Garbha 16 bada bahala 18'3 pabhaga 8'1 tala jangha 7'1 bandhana 1'87 upar jangha 7'2 baranda 8'2 gandi 41'6 beki-amla-khapuri 14'5 kalasa 5'6 total 88 57. Proportion 1 : 5'53.

(11) *Sari Deul,* Bhubaneswar. Garbha 16 bada bahala 13'7 pista nasti pabhaga 6 26 tala jangha 4'95 bandhana 1'78 upar jangha 5'2 baranda 6'15 gandi 36'25 beki-amla-khapuri 15'8 kalasa 3'35 (?) total 76'39. Proportion 1 : 4'77.

(12) *Sinhanath,* Baramba State. Garbha 16 bada bahala 17'2 pista

bisama 35 beki-amla-khapuri 10'2 kalasa 7'6 total 69'51. Proportion 1 : 4'32.

(13) *Ramanath*, Baud State. Garbha 16 bada bahala 12'4 pista-upana 12'8 pabhaga 6'1 jangha 12'3 baranda 2'14 kanti 1'16 gandi 36'3 beki-amla-khapuri muhanti 10 khapuri-(broken) kalasa 5'15 total 73'15. Proportion 1 : 4'5.

(14) *Gandharadi*, Baud State. Garbha 16 bada bahala 15'5 pista nasti pabhaga 7'1 jangha 14'2 baranda 2'6 kanti 1'34 gandi 41 beki-amla-khapuri 10'4 pillar-like object (linga?) 6 total 76'64. Proportion 1 : 4'79.

(15) *Somesvara*, Ranipur-Jharial, Patna State. Garbha 16 bada bahala 12'4 pista nasti pabhaga 4'2 jangha 14'5 baranda 2'1 kanti 0'88 gandi 30 beki-amla-khapuri muhanti 5'05 remainder (?) total 59'73 +. Proportion 1 : 3'73.

When we compare these figures and proportions carefully, and also note that on epigraphic grounds, Gokarnesvara belongs to the 11th century while Parasuramesvara to the 8th, and that yet they show striking similarity in architectural characters, while Gandharadi shows a wide departure, the value of depending on an evolutionary series based on outside megascopic characters becomes very doubtful. We have again to remember that temples of apparently the same outward form may differ immensely in the matter of interior construction. Thus the Bhimesvara temple in Mokhalingam has proportions similar to other temples with three elements in their bada; yet in its interior, it rises to a point without any *garbhamuda* or *ratnamuda*, while Parasuramesvara has a completely closed ceiling, and the ruined temples near Rameswara in Bhubaneswar have a celing of another kind.

These interiors were described by me in the *Bangiya Sahitya Parishat Patrika* in 1346 B. S. (pp. 91-8). They only served to show that temples could not be equated by outward similarities alone, for the latter may mislead us completely.

It is therefore of the utmost importance to discriminate very carefully between one element and another in the analysis of a temple; and only when we have gained the confidence that the significant characters have been duly chosen, we can proceed to create an evolutionary series on the basis of a study of their change. Where dated temples are abundant, a whole series for purposes of reference can perhaps be built up with their help. But when most of the temples are without date, then we may try to employ the Distribution Method for converting Space into Time. But then, as we have said, this has to be corroborated by the first series, and its worth, or probability of error, *i.e.*, dependability, duly notified.

What is needed to-day is that, in each province of India where temples are present, workers should employ uniform means of analysis of the structural elements. When enough data are available, distribution maps of significant elements should be drawn, and inferences drawn with regard to the course of evolution followed all over India. As the nature of changes to which Rekha temples were subjected was not uniform in different places, the evolutionary scale set up in one province would naturally have limited value in another. Therefore, in each province, the dated temples should also be employed to build up another local series. This would serve to check and to supplement the findings of the Distribution Method itself as applied to that particular locality. And when we have all these tables and detailed analyses before us, then alone we shall be able to reconstruct the story of the evolution of the Rekha Order with some amount of assuarance. And in this effort, we should have also lifted our sciences to higher levels of reliability.

That is surely a task to which we should feel sufficiently attracted.

36th INDIAN SCIENCE CONGRESS, ALLAHABAD, 1949.

SECTION OF MEDICAL AND VETERINARY SCIENCES

PRESIDENT : DR. M. B. SOPARKAR, M.D., B.Hy., F.N.I.

Presidential Address

SOME ASPECTS OF TUBERCULOSIS IN INDIA AND MEASURES FOR ITS CONTROL

INTRODUCTION

I must first thank the members of the sectional committee of the Indian Science Congress for the honour they have done me by electing me to preside over the deliberations of this section of Medical and Veterinary sciences this year and I greatly appreciate it. No one is more conscious of my shortcomings than I am and I trust you will accord me all the co-operation to make the session a success.

The subject of my address is " Some Aspects of Tuberculosis in India and Measures for its Control." I have chosen the subject of tuberculosis not only because I have spent more than twentyfive years in the study of the various aspects of the disease both in man and animals but also because the subject is of vital importance to India at the moment. This is all the more so because India, although taken to be mainly a subcontinent of villages, is becoming rapidly urbanised. The pace of urbanisation has been alarming. I said alarming purposely because the defences of our cities against a disease like tuberculosis are yet weak and poor and as such we have to do everything in our power to strengthen the defences.

I will devote the first part of my address to those aspects of tuberculosis which affect animals—particularly cattle—not only because of its intrinsic importance from the agricultural and veterinary standpoint but also because it has an important bearing on human disease. The second part will deal with the disease in relation to its control and eradication in India as it affects human beings.

Unlike many other diseases which are only experimentally transmissible, tuberculosis occurs as a natural infection in various species of animals, birds, etc. Of special interest are those animals which are of great economic importance to man *e.g.* cattle. Our food minister the Hon. Mr. Jairamdas Doulatram, in opening a cattle show recently said, "Cattle play a very important part in the national economy of the country. Importance of cattle wealth to our predominantly agricultural country need not be emphasized. Cattle are the backbone of agriculture and 80% of India's rural population is agriculturist. We possess about one third of the total cattle population of the world. We want more milk and better and stronger bullocks." It is necessary, therefore, to see that they are kept free from disease. One of the diseases which affects them is tuberculosis.

TUBERCULOSIS AMONG CATTLE

The general impression for a long time has been that in India tuberculosis among cattle is rare. A systematic examination by Taylor of over 6000 selected cattle slaughtered at Ferozepore records the finding of about 3.5 per cent affected with the disease. Cases of tuberculosis have been recorded among conservancy bullocks in Madras by Krishnamurty and in the Bombay Presidency by Sowerby and in Calcutta jail by Kerr.

RESISTANCE OF INDIAN CATTLE TO TUBERCULOSIS

Experiments were carried out to find if this infrequency of the disease as compared to the higher frequency in Europe was due to any natural resistance to the disease possessed by Indian cattle. The results of the experiments showed that although some of the Indian calves tested were as susceptible as the English calves, a certain proportion of Indian calves of all breeds including European crossbred calves were possessed of high powers of resistance to artificial infection as compared to English calves.

The resistance displayed by a certain percentage of Indian cattle to a test dose that almost invariably produces a fatal result in English calves was not due, as has been suggested, to the presence in them of a minimal latent infection which probably had a vaccinating effect upon the tested animals, because all the animals were previously tested with tuberculin with negative results.

The only other explanation would be that the tuberculin test failed to reveal the latent infection. This explanation also would not appear to be tenable as the application of tuberculin test in Indian cattle has, on the other hand, in many cases given a high percentage of reactions which were considered probably false due to the prevailing belief of the rarity of tuberculosis among Indian cattle.

The important problem would be to find out the precise nature of the relative resistance displayed and the circumstances that favour the development of such resistance so that the results may be made applicable to human beings. Direct sunlight of the tropics may have some possible effect in producing this resistance in these animals owing to their being kept mostly in the open in India. Ukil has done some work on the subject.

Open air life, however, would only reduce the chances of massive natural infection but would not give the animals power of resistance against a *massive experimental* infection.

The Expert Committee on Tuberculosis appointed under the World Health Organisation—Interim Commission—at its second session in Geneva in February 1948 in one of its recommendations under the heading *Research* observes:

> "In view of the fundamental importance of the laboratory and field studies being made in different countries to determine the main nutritional factors responsible for decreased or increased susceptibility to tuberculosis the Committee strongly recommended that these studies be intensified and extended."

I need not, therefore, further stress the importance of extending these studies.

INCIDENCE OF TUBERCULOSIS IN CATTLE IN INDIA

A study of the incidence of the disease was made by us in certain parts of India and animals slaughtered in the abattoirs were examined for naked eye lesions of tuberculosis. At Ferozepore 85 out of 507 cows (over 16 per cent) showed gross lesions and in 74 of these (14 per cent) tubercle bacilli were detected microscopically. In another batch of 416 animals examined the percentage of animals showing gross lesions was 17.54. In Lahore 1116 animals were examined out of which 255 or 22.85 per cent were found affected mainly with glandular lesions of tuberculosis. The animals consisted of cows, buffaloes and bullocks. Out of 357 cows examined 67 (or over 18 per cent) were found affected. Out of 642 buffaloes 152 (or over 23 per cent) were found affected and out of 117 bullocks 36 (or over 30 per cent) were found affected. Acid-fast bacilli were found in 85 to 90 per cent of the affected animals. In five cases generalised tuberculosis was found. Stress is laid on the detection of tubercle bacilli microscopically, as Calmette states that it is difficult to demonstrate tubercle bacilli by microscopic examination in tuberculous glands of animals.

There has been a general belief that buffaloes are more resistant than cows to infection with tuberculosis and do not suffer to the same extent.

Col. Wilkinson (1914) in his notes on the prevalance of tuberculosis in India observes: " A still further factor in the elimination of infection through milk is the fact that buffaloes...... are even less affected with tuberculosis than are cows."

Our findings as explained above, show that this belief is erroneous.

Sir George Newman in his memorandum on bovine tuberculosis with special reference to infection by milk states that the milch cows are more prone to be tuberculous than young cattle and other bovine animals.

We have found that conditions in India differ from those in European countries. We have found upon examination of more than 100 bullocks as stated above, that the percentage of tuberculosis among these animals, contrary to the experience of Sir George Newman, is even higher (over 30 per cent) than in cows (over 18 per cent).

The incidence of infection detected in India is about equal to that found in European countries where bovine tuberculosis is known to be prevalent and even exceeds those in some parts of Europe and America.

The animals examined in the Punjab were those passed by the veterinary authorities as healthy for slaughter and 18 percent of those so passed were rejected for poor condition and no rejected animal could be examined. If these were examined the incidence would probably be higher.

Again the percentage of infected animals detected in the Punjab represents those presenting gross tuberculous lesions in the thoracic cavity which alone could be examined and no systematic examination of the whole carcass could be carried out. This circumstance again would point towards the probability of a still higher incidence if the examination could be more inclusive and thorough.

Further, if the incidence is based upon results of tuberculin test, as is done in most European countries which detects even minute lesions—the so called non-visible lesions—it would probably reveal a still higher incidence of the disease.

The high incidence of tuberculosis detected among cattle would not appear to be restricted to Ferozepur and Lahore alone. An investigation on a small scale was made at Shaharanpur and 20 cattle from the remount depot reported to be in a bad condition were tested with the double intradermal tuberculin test. Thirteen out of twenty (or 65 per cent) reacted, eight of these to ordinary human tuberculin and five to avian tuberculin; while two were suspicious and five were negative. All animals were destroyed and careful post mortem examination revealed naked eye lesions in four and one more proved tuberculous on animal inoculation. Strains isolated from these animals proved to be of the bovine type.

Indra Jit records the incidence of infection among buffaloes at Montgomery where out of 26 animals examined 15 or 57.69 per cent were found tuberculous.

Annual report of the Imperial Veterinary Research Institure, Muktesar, for the year 1939-40 states that the incidence of tuberculosis among draught bullocks of the Puri Municipality has been found to be over 80 per cent many of the animals showing acute generalised lesions. Tuberculosis was also found in 6 out of 250 buffaloes examined at the Municipal abattoir, Bareilly.

Naik has found 5.4 per cent reactors to tuberculin test among cattle and 13.5 per cent among buffaloes in the Bombay Province during seven years previous to 1938-39.

VIRULENCE OF TUBERCLE BACILLI AFFECTING INDIAN CATTLE

Sheather as a result of his experiments carred out at Muktesar came to the conclusion that the comparative infrequency of tuberculosis among cattle in India was due to a lower virulence of the strains of tubercle bacilli infecting cattle in India than that of the strains infecting cattle in Europe. We have not been able to corroborate these findings. Our experiments have shown that the strains of tubercle bacilli isolated from cattle in India are as virulent as those of European origin.

We have isolated and studied the characters of over forty strains from tuberculous Indian cattle and as a rule all of them were found to be of the bovine type except in one instance of a conservancy bull from Madras from which the organisms isolated were found to be a mixture of bovine and avian tubercle bacilli.

NATURAL INFECTION OF INDIAN CATTLE BY HUMAN TUBERCLE BACILLI

In the course of examination of the carcases of cattle for the presence of tuberculosis attention was paid not only to gross lesions such as would easily be detected with the naked eye but also to suspicious lesions in which no definite evidence of tuberculosis could be detected but at the same time the tissues did not appear quite normal. Seventy such specimens of suspicious lesions were collected from Ferozepur for examination. Animal inoculations led to the isolation of two strains.

While the strains previously isolated from cattle showing gross naked eye lesions all showed characters of bovine type, the two strains isolated from suspicious lesions showed that they belonged to the human type.

Cattle are as a rule not known to be infected under natural conditions with tubercle bacilli of the human type. Indeed, Park and Krumwiede observe: "Considering the fact that in no instance has a culture been isolated directly from cattle showing the characaters of the human type the question of possible infection of cattle from man under natural conditions is practically settled."

The two cases of cows infected with human tubercle bacilli orginally reported in 1931 (vide report of the Scientific Advisory Board, Indian Research Fund Association, 1930-31, p.37) would appear to be the first instance to be recorded of natural infection of cattle with bacilli showing characters of the human type. Recently Griffith (Jour. Hyg. June 1936, p.164) has also recorded a case of a calf infected with tuberculosis from which tubercle bacilli of the human type were isolated and he mentions this as the second case recorded; his first case reported in 1913, was in a calf which was reared on milk from cows which when young were inoculated artificially with human tubercle bacilli under experimental conditions and therefore cannot be regarded as one of infection under natural conditions.

The two cases of human tubercle bacillus infection of cows occured in animals brought to the slaughter house in Ferozepur and had come from the surroundig districts in the Punjab and had in all probability derived their infection from phthisical human cases. In the case recorded by Griffith a consumptive person was afterwards ascertained to have been in contact with the calf. These instances indicate the danger of allowing phthisical persons to attend on milch cattle.

Although cattle are not as susceptible to infection with human type of tubercle bacilli as they are with the bovine type, yet they are known to be capable of harbouring this infection and of excreting these bacilli in milk without the udder being grossly affected as has amply been demonstrated by workers under the Royal Commission on Tuberculosis. This infection, therefore, if found on investigation to be prevalent among Indian cattle would constitute another source of danger to public health. Some indication in this direction is afforded by the fact that in the course of work on tuberculin tests upon Indian cattle a disconcertingly large proportion of them was found to give a positive reaction. These findings could not be reconciled with the then existing knowledge regarding the incidence of the disease among cattle in India which was considered to be rare, and it was thought that the apparent reaction was probably due to the wide and capricious variations of temperature in Indian cattle.

But our later investigations showed that when these reacting animals were killed and subjected to careful post mortem and bacteriological examinations, tubercle bacilli could be isolated even from some of those which showed no naked eye lesions (the so-called no lesion reactors). In some cases the bacilli isolated were found to be of the bovine type and fully virulent. In these two cases they were found to be of the human type. Gradually therefore, the apparent mystery of the high percentage of tuberculin reactors among Indian cattle is being unravelled.

The whole question of tuberculosis in cattle requires a thorough investigation and in the words of Dr.Krause "Whatever will keep cattle from getting tuberculosis will also eventually be found to prevent the disease in man".

In this connection it may be urged that there should be close co-operation between medical and veterinary professions particularly in regard to research in tuberculosis as this disease whether in man or in animals is one problem from the experimental standpoint and cannot be divided into watertight compartments one pertaining to animals and the other to man.

TUBERCULOSIS AMONG ANIMALS OTHER THAN DOMESTIC CATTLE

Besides cattle several other species of animals suffer from natural tuberculosis. In association with Col. Liston an outbreak of tuberculosis among animals in the Zoological gardens in Bombay was investigated by the speaker and a large number of animals of different species including Llama, spotted deer, nilgai, sambar, antelope, arabian gazelle and malayan tapir were found to be suffering from tuberculosis. The infection was traced to a Llama originally imported from Germany. Strains isolated were found to be of fully virulent bovine type. About 15 years after the first out-break several sambars in the garden were found to be suffering from bovine tuberculosis. In view of these findings and the chronic course the disease often takes in animals, there is an obvious danger of infection of visitors who visit the gardens daily in large numbers from the animals suffering from tuberculosis. Indeed it is likely that the case of bovine tubercle bacillus infection found in a girl from the Cama hospital, Bombay, and reported by the speaker may have derived its infection from some of these animals suffering from bovine tuberculosis in the gardens which children are fond of visiting.

TUBERCULOSIS AMONG SWINE IN INDIA

Next to cattle swine are the commonest subjects for tuberculosis. The speaker had found that swine in India also suffer from tuberculosis. Out of 245 animals examined in Bombay about four percent of pigs slaughtered for food showed evidence of tuberculosis mostly localised. Examination of the types of strains isolated showed that all of them belonged to the human type. These results are in marked contrast to the findings of Van Es and Martin in America where a large proportion of cases of swine tuberculosis (88.5 per cent) were found to be due to the avian tubercle bacillus. In England Griffith found bovine type of infection in 85 per cent of cases examined and avian and human types in lesser proportions. The incidence of the disease varies in different countries.

I have also found camels in India showing infection with tuberculosis. Out of over 800 camels examined by the tuberculin test 9 or about one per cent reacted indicating infection. Instances of tuberculosis among elephants and horses were also met with and have been recorded by other workers at the Indian Veterinary Research Institute.

SURGICAL FORM OF TUBERCULOSIS

At the meeting of the Second All-India Veterinery Conference held at Calcutta (1923), Major-General (then Col.) Hutchinson stated that the so-called surgical form of tuberculosis such as bone and joint tuberculosis, glandular tuberculosis and other closed types of tuberculosis occurs in India in the same propotrion as it does in the Western countries, and he laid stress upon the necessity of investigating the organism responsible for this form of human tuberculosis in India. Col. Bradfield in a paper in the *Indian Medical Gazette* (June 1925) draws attention to the frequency of this type of tuberculosis in Madras. Lankester in the course of his enquiry into the prevalence of this disease found that it is met with frequently in the Punjab, United Provinces, Gujerat and Bombay. Hospital experience bears abundant evidence of the prevalence of this form of disease in India. Extensive investigations have been carried out as to its causation in European countries—principally by Griffith in England, Mitchell and Fraser in Edinburgh, Parke and Krumweide in America and others. Their investigations have shown that this type of disease is caused in a large proportion of cases, especially in young children, by the bovine bacillus, which in all probability gained entrance into the body principally through ingestion of infected milk. For the sake of brevity I am not giving details of Griffith's investigations.

In India as has already been stated these forms of tuberculosis are met with frequently and it is necessary to investigate their origin. In the course of our investigations we have examined 158 cases comprising cases of glandular tuberculosis, bone and joint tuberculosis and pulmonary tuberculosis. Of these, 56 cases were from children under 16 and 102 were from adults. From these 90 strains were isolated and studied. In two of these cases, both of glandular tuberculosis, the infection was found to be caused by the bovine bacillus, and in one case it was found to be caused by the avian type of bacillus. In the rest of the cases the infection was found to be caused by the human type of bacillus. These findings would appear to show that the bovine bacillus does not play any important role in the causation of human tuberculosis in India in spite of the high incidence now recorded of the disease among cattle. This is mainly because of the almost universal practice of boiling milk. Nevertheless a potential danger would remain. Ukil has carried out similar investigations and out of 50 strains isolated from glandular and bone tuberculosis none was found to be of the bovine type. Indra Jit and Mallick, Aggarwal and Dua have also investigated the subject of bovine tubercle bacilli and extrapulmonary tuberculosis in the Punjab but no bovine bacilli were found.

EXPERIMENTS ON IMMUNISATION AGAINST JOHNE'S DISEASE

Intravenous inoculation of cattle with living avian tubercle bacilli has been used for the purpose of preventive vaccination against another disease of cattle called Johne's disease caused by an acid-fast bacillus closely allied to tubercle bacillus and known as para-tubercle bacillus or Johne's bacillus. Animals suffering from this disease do not react to ordinary tuberculin prepared in the usual manner from human (or bovine) tubercle bacilli but react to tuberculin prepared from avian tubercle bacilli. This method of inoculation however is found to have a very severe effect, as living avian tubercle bacilli administered intravenously to cattle are known very often to produce fatal results. Experiments were undertaken to find out a method of averting this fatal result and to see if previous inoculation with different types of tubercle bacilli confer any protective power against the effects of intravenous inoculation later of living avian tubercle bacilli.

Calves inoculated subcutaneously with the three types of tubercle bacilli, *viz.*, human, bovine and avian and discontinued from other experiments, together with uninoculated control animals were obtained and were tested against intravenous inoculation in doses varying from 10 to 200 milligrams of living avian bacilli. Results showed that while over 63 percent of control animals died as a result of this test inoculation, those previously vaccinated with human tubercle bacilli succumbed mainly to larger doses of avian bacilli and likewise those vaccinated with bovine bacilli. The percentage was 20 among the former and 36 among the latter. But not one of the 16 calves previously inoculated subcutaneously with avian bacilli died as a result of intravenous test inoculation even with doses as large as 100 or 200 mgms. The results of these experiments suggest the possibility of averting the fatal effects in cattle following upon intravenous inoculation of avian tubercle bacilli by previous treatment of the animals by subcutaneous method, thus rendering safe the method of preventive inoculation of cattle against Johne's disease by the application of living avian tubercle bacilli.

THE NATURE OF THE ALLERGIC REACTION IN TUBERCULOSIS

It is a well-known fact that when dilute solutions of tuberculin are injected into the skin of a normal animal no visible changes occur, but when similar injections are made into the skin of a tuberculous animal acute inflammation accompanied by all the classical signs, *e.g.* heat, redness, swelling, tenderness, etc. occurs, the degree or the severity of which depends upon the sensitiveness of the subject and the dose and the concentration of the tuberculin injected. Although several hypotheses have been put forward from time to time the actual mechanism of this reaction has not hitherto been satisfactorily explained.

According to the hypothesis developed from the work of Maurice Nicolle and of Wolff-Eisner the tuberculous body contains lysins for the tubercle bacilli as well as for its endotoxin-tuberculin and the product of this lysis is toxic and causes acute inflammation.

Partial support is afforded to this view by the work of Bail who claimed that while tuberculin alone was not toxic to normal animal it became so if crushed tuberculous tissue was injected into the normal animal simultaneoulsy with tuberculin.

Krauss, Loewenstein and Volk, Selter, Klopstock and others, however, could not confirm these results.

Zinsser and Timiya obtained though irregularly and inconsistantly, tuberculin-like reaction in normal animals injected with mixtures of tuberculin and tuberculous tissues. Neither tuberculin alone nor the tuberculous tissue caused any reaction in the normal animal. From this the authors concluded that tuberculous tissue had by some means rendered the tuberculin toxic.

Long, however, obtained contradictory results but admits that his results are inconclusive. It is thus evident that so far no satisfactory experimental proof has been brought forward to explain the mechanism of this reaction.

We have carried out certain experiments to study the nature of this allergic reaction and particularly the phenomenon of inflammatory reaction occuring in the healthy skin of a tuberculous subject when tuberculin is injected intradermally into it. What is it that actually causes this reaction? Is there any substance that is present in the cells of the normal skin of the tuberculous animal which coming in contact with tuberculin renders it toxic? If so, can the presence of such a substance or of the toxic product be demonstrated?

With a view to elucidating this problem an extract was obtained from the ground up pieces of healthy skin of a tuberculous bull. This animal had received during the previous two years inoculations of large doses of human and avian tubercle bacilli and had died following injection of bovine tubercle bacilli. Pieces of its healthy skin which was free from any lesions were removed and an extract of it was obtained after crushing. This skin extract was tested for its property of activating tuberculin.

It was mixed with tuberculin in different proportions and left in contact with it for varying periods of time and the different tests were carried out on a healthy bull and a buffalo. These different tests were done on one and the same animal for obvious reasons.

Different spots were selected at a distance of a few inches on the sides of the neck of the animal, the material was injected intradermally and observations were made every day for three or more days. The presence or absence of reaction was judged by palpation of the injected spot but for purposes of record the thickness of the injected spot on the skin was measured in millimeters by means of callipers and the measurements plotted out on charts.

The results show, firstly that in a healthy normal animal injection into the skin of tuberculin alone does not produce a skin reaction. Secondly, when the skin extract alone is injected intradermally this too does not produce a reaction. Thirdly, when the skin extract and tuberculin are mixed together and the mixture soon afterwards is injected intradermally this also fails to elicit a reaction. But when the contact in vitro of the skin extract and tuberculin is prolonged for several hours, a marked reaction results in the normal animal resembling the reaction produced by the tuberculin in a tuberculous animal.

Further it was found that when the serum of a tuberculous animal was used in place of the skin extract no reaction was produced on intradermal injection either of the serum alone or of the mixture of serum and tuberculin, whether fresh or after prolonged (several hours) contact indicating that the body, whatever it be, which is responsible for the development of the toxic substance when mixed with tuberculin is not present in the serum.

In order further to see if this body is present only in the skin of a tuberculous animal and not in the skin of a healthy animal similar extract was obtained from the skin of a healthy bull. Intradermal injection of this normal skin extract either alone or its mixture with tuberculin, whether fresh or after prolonged contact, failed to give rise to any skin reaction, again indicating that the substance which activates tuberculin is not present in the skin of a normal or non-tuberculous animal.

We have thus seen that when the healthy skin extract derived from a tuberculous bull is mixed with tuberculin and is allowed to act for some time, a toxic product results from the inter-action which produces, when injected intradermally in the normal animal, a skin reaction resembling that produced by tuberculin in the tuberculous animal.

These positive results are in contrast to the negative results obtained by E.R. Long and may perhaps be due to the difference in the kinds of animals used in the respective experiments and also perhaps, to the period of contact and the quantitative and other factors involved in the reaction.

These are only preliminary experiments made, be it noted, with normal tissue and not with tuberculous, tissues. The results so far, have for the first time to our knowledge, demonstrated the presence of a toxic product and afford a direct experimental proof in support of the hypothesis that in the apparently normal skin of a tuberculous animal are present certain substances which when brought in contact with tuberculin render it toxic so that it causes an inflammatory reaction in a normal animal.

TABLE 1.

SKIN TESTS ON A NORMAL BULL

No.	Material injected	Quantity Injected	Maximum Thickness of skin in millimeters		Results
			Before injection	After injection	
1	Concentrated tuberculin alone	0.4cc	4.5	9.6	No reaction
2	Skin extract alone	0.4cc	4.0	7.0	No reaction
3	Mixture of skin extract 2 parts, pure tuberculin 1 part. Fresh (15 minutes)	0.4cc	4.0	6.4	No reaction
4	Skin extract alone	0.5cc	4.0	8.4	No reaction
5	Mixture-skin extract 2 parts, tuberculin 1 part. 18 hours contact	0.5cc	5.0	9.2	Doubtful
6	Mixture-skin extract 5 parts, pure tuberculin 1 part. 40 hours contact	0.6cc	4.0	18.0	Positive reaction
7	Skin extract alone as control of No. 6	0.5cc	3.8	6.0	No reaction
8	Mixture-skin extract 5 parts, pure tuberculin 1 part. 94 hours contact	0.25cc	3.5	12.3	Positive reaction
9	Mixture-skin extract 5 parts, pure tuberculin 1 part. 114 hours contact	0 ·25cc	4 ·3	20·5	Positive reaction
10	–do– 7 days contact	0 ·1cc	4 ·5	19 ·0	Positive reaction
11	–do– 10 „	0 ·1cc	4 ·9	18 ·3	Positive reaction

THE FILTERABLE FORM OF THE TUBERCLE BACILLUS

The claim that there exists a filterable form of the tubercle bacillus has not received general acceptance and there are outstanding names amongst supporters as well as antagonists of this hypothesis.

We have carried out several experiments on this subject using suspensions of autolysed tuberculous sputum containing human bacilli and ground up animal tissues with bovine bacilli, mixed with B. prodigiosus as a control organism for filtration through Chamberland L3 candles and subsequent inoculation of the filtrates into guinea-pigs, later making successive passages of the material in series from guinea-pig to guinea-pig and examining the tissues of such animal for acid-fast bacilli microscopically as well as by culture.

Ten such experiments were made and acid-fast bacilli were detected in all the experiments. Further, pure cultures were isolated in six of them and five of these different strains were studied.

The study of their characters showed that these strains, which were derived, three from filtrates of sputa containing human bacilli and two from animal tissues containing bovine bacilli, differed from the original strains both culturally as well as biologically and were avirulent for the guinea-pig and showed pathogenic characters resembling the avian bacillus and in broth they produced homogenous cultures but no surface growth like that of classical tubercle bacilli.

In two instances again an intermediate stage was also recovered in addition, from two of the passage guinea-pigs. This intermediary strain was found to be non-pathogenic for the guinea-pig, rabbit and also the fowl and in broth it produced a surface growth like the classical tubercle bacillus.

Nearly identical results were obtained by Valtis, Negre and Van Deinse in Paris. These findings afford evidence of the existence of a filterable form probably representing a stage in the evolutionary cycle of the tubercle bacillus.

TUBERCULOSIS CONTROL.

I shall now turn to immediate practical problems. By far the most important is the problem of prevention and eradication of tuberculosis in man.

No reliable data are available regarding the prevalence of tuberculosis in India. But judging from mortality figures and sample surveys undertaken in different parts of the country, Dr. Benjamin in his memorandum on Tuberculosis (1943) estimated that at least 5,00,000 deaths occur annually from tuberculosis. Mortality figures for large cities show tuberculosis death rate of from 200 to 450 per 1,00,000. A recent report from Bengal gave a 7 per cent motality with 3 per cent open cases in the general population.

Lankester in his comprehensive survey of tuberculosis in India (1920) estimated that approximately one out of every 7 or 8 deaths was due to tuberculosis and one out of every 3 of adults in cities. This shows that tuberculosis is one of the most prevalent cause of death. If the ratio of tuberculosis deaths to cases is accepted as 1 to 5 then there will be at least 25 lacs of open cases of tuberculosis at any given time.

In Western countries where tuberculosis control has made good progress provision of adequate number of beds for the isolation and treatment has been emphasized. The most important contributing factor to the lowering of the death rate from tuberculosis in those countries has been the number of beds available for treatment and isolation of tuberculosis patients, *viz.* for every 100 deaths Great Britain has about 100 beds, Denmark has 189 beds, Sweden has 170 beds, New York State has about 300 beds (outside the city).

Experience in America has shown that where accurate mortality figures are available two beds for every recorded annual death may be provided. Where vital statistics are unreliable an approximate estimate of the beds requirements may be made on the basis of one bed per thousand population.

In America as a result of the intensive efforts at tuberculosis control a stage has been reached at which the biological balance is against the survival of the tubercle bacillus and, as demonstrated by the steadily falling morbidity and mortality rates, each succeeding case has for some time been giving rise to less than one new case of the disease. Dr. Wade Hampton Frost declared "if this balance can be maintained and the sources of infection further reduced the control of tuberculosis is within our grasp".

The steady fall in the death rate from tuberculosis in the United States of America is shown by the following few data. In 1890 the tuberculosis death rate in U.S.A. was 245 per 1,00,000 population. . In 1900 the figure was 202, in 1910 it was 160, in 1920 it was 114, in 1930 it was below 76 and inspite of the rigours of war time in 1944 it was 41.3 and the death rate from tuberculosis in the United States for 1947 has come down to 37.4 per 1,00,000 population. As will be seen, the reduction in the death rate from tuberculosis in the West and especially in America has been mainly due to the provision of an adequate number of hospital beds, sanatoria and the adoption of similar well-estatlished methods.

To make similar provision in India, at least 500,000 (five lacs) beds are required for tuberculous patients instead of the present 7,000 beds; 4,400 clinics are wanted instead of the present 120; 13,000 tuberculosis officers are needed instead of the 200 now available, according to figures given by Dr. Benjamin at the Conference held under the auspices of the National Association for the Prevention of Tuberculosis, London, in July 1947.

For India he would suggest the employment of the general framework which has proved its usefulness in the West *viz* clinics, hospitals, sanatoria and aftercare provision.

The cost to the country in providing a sufficient number of beds can now be rapidly surveyed from available data.

America provides figures which will help us to get some idea. The capital expenditure on sanatoria and tuberculosis hospitals there, has been about 300 million dollars in the last forty years, and the annual expenditure on tuberculosis hospitals is about 70 million dollars, on clinics about 10 million dollars, other costs about 15 to 20 million, a total of 100 million dollars.

Estimating the cost of a similar campaign in India it has been found that the annual cost of treatment in a tuberculosis institution, if all expenses including medical staff are taken into consideration, is about Rs. 750/- per head including food in normal times.

Assuming that standard of one bed per tuberculosis death were to be attained and that there are about 5,00,000 deaths a year, the annual cost would be Rs. 37,50,00,000/-. Adding one third more for preventive work and clinics, the total expenditure would come to about 50 crores of rupees for the whole India.

At the present time, however, a superintendent of a large hospital is reported to have recently remarked that a single day's longer detention of a patient in the hospital bed would cost the Government not Rs. 2/- but Rs. 6/- (per bed per day). At this rate it would cost Rs.150/- crores for provision of hospital beds, clinics etc.

This is so enormous a sum to spend on one disease that the country in the present circumstances can hardly afford it. If someone asked for this sum for tuberculosis treatment, the scheme would be condemned from the very start. Even assuming that the funds required were available the personnel required is not available and will take many years to train. Further, as the whole scheme cannot be implemented at once but only gradually, the progress would be very slow. It will take decades before the disease can be controlled to any appreciable degree by the conventional methods of hospitalisation and individual treatment. The problem is so vast and so urgent that we cannot afford to wait till then. Our approach to it should be different. We have to take some action in the meanwhile. The only solution to the problem appears at the present moment to be *mass immunisation* which will fortify the body and thus render the soil barren for the seed of the tubercle bacillus that may be implanted upon it by open cases.

The method which has of late been widely accepted is the method of preventive vaccination with B.C.G. As tuberculosis is a world problem the World Health Organisation of the United Nations Organisation has taken it up and has decided that at the present moment vaccination with B.C.G. is the only tried method by which the disease can be controlled in all parts of the world. It has chalked out a program for ten countries of Europe where 50 million children would be tested with tuberculin of whom about 15 million would probably have to be vaccinated.

Experience of over ten million vaccinations with B.C.G. has demonstrated the safety and harmlessness of the measure and the protection it affords. As regards costs, the experience in São Paulo in Brazil has shown that whereas a single bed in a sanatorium costs 2.5 dollars per day approximately or 912 dollars for a single patient to be kept for one year, within that sum about 10,000 persons can be given protection by B.C.G. vaccination.

It is a strange coincidence that at the 17th session of the Indian Science Congress held in this very city of Allahabad nineteen years ago (1930) I had read a paper on the results of my investigations on the "Innocuity and Immunising property of B.C.G." and that I should be standing before you in this very city today after 19 years now in the capacity of the President of the section, to urge again the adoption of this measure for the fight against tuberculosis. And, if I may add another personal note, I had already last year submitted a Scheme for vaccination against tuberculosis by means of B.C.G. to the Surgeon General with the Government of Bombay.

B. C. G.

Now a few words about B.C.G. This was originally a virulent bovine strain which Calmette and Guerin succeeded in attenuating by prolonged cultivation through 230 generations over a period of 13 years on a medium of potato saturated with Oxbile, as a result of which the strain has been claimed to have lost all its virulence and pathogenicity and thus to have become permanently avirulent and non-pathogenic and to confer considerable immunity.

The general opinion of a large number of investigators as a result of experiments on animals and vaccination of human beings is that B.C.G. is safe and harmless and that there is no risk whatsoever of the vaccine causing infection, at the same time it gives some protection against tuberculous infection as does natural infection with virulent bacilli. It is often argued that natural tuberculisation is taking place throughout life and in European countries at the age of over 50 nearly 90 per cent of the population shows evidence of previous infection, only a small portion of which is affected with clinical disease—the rest having developed immunity. In answer to this it has to be stated that this bacillisation is haphazard and such infection with unknown bacilli of unknown virulence as well as of unknown dose and frequency is dangerous. It would be prudent to replace this by the known B.C.G. vaccination which has now been proved to be safe and effective. During the conference held in December 1945 under the Danish Ministry of Health it was pointed out that there appeared to be general agreement as to the effectiveness and harmlessness of B.C.G.

Among the conclusions of the conference on B.C.G. vaccination held on 7th September 1946 in the office of the Tuberculosis Control Division of the U.S. Public Health Service in Washington D.C. it is pointed out that medical literature fails to reveal any proved case of progressive disease as a result of B.C.G. vaccination.

TOLERENCE

Calmette states that a healthy man can tolerate 1 mgm. of B.C.G. injected intravenously, and tuberculous subjects themselves are not injuriously affected by subcutaneous injection of doses upto 10 mgms. These injections merely give rise to local abscesses as an expression of Koch's phenomenon, but would be ineffectual. Doses of 10 mgm. orally repeated three times at 48 hours interval produce no physiological disturbance in young children or in young suckling animals. Bruno Lange and K. Lydtin at the Robert Koch Institute have further demonstrated that B.C.G. emulsion can be inhaled without ill effects.

PROTECTIVE VALUE OF B.C.G.

As a result of numerous experiments Calmette has shown that vaccination with B.C.G. confers a certain degree of immunity on the person against tuberculous infection. This immunity develops about 4-6 weeks after vaccination and lasts about 2-4 years.

During the first 10 years Calmette's results regarding the innocuousness and protective power of B.C.G. were much criticised. In reply to various criticisms against B.C.G. Calmette, among other observations remarks, "Of 579 children who were vaccinated more than four years previously and who have lived continuously in the tuberculous families and surroundings not one has died. This proves that B.C.G. has at least been innocuous for these 579 children and has protected them against bacillary infection to which they have been exposed during four consecutive years when the general mortality including tuberculosis mortality during the first year of life in children born and brought up in tuberculous surroundings ranges from 7.4% to 71.5%. The latter figure applies to children under two years who have been exposed to infection during first three months of life. Calmette asks: "Can one wish for a clearer demonstration of the preventive advocacy of B.C.G.?"

Experience in Denmark with vaccinated children intimately exposed to open tuberculous infection shows that tuberculous disease has been reduced to almost nothing after systematic B.C.G. vaccination has been carried through.

Weill Halle states that he has never seen a case of tuberculosis among several thousand vaccinated persons observed during 25 years even in those living under exposure provided that the vaccination took place under favourable conditions of freedom from exposure at the time and that revaccination was carried out when allergy disappeared. Among those vaccinated by the scarification method since 1939 tuberculosis mortality has been nil.

The experiment undertaken by William H. Park at New York has been particularly suggestive because it deals with a small number of children all born of tuberculous mothers in hospitals and regularly controlled. Upto 1st January 1930, 208 of these children have been vaccinated, 350 non-vaccinated remaining as controls. After three years the following results were noted by the author : "Tuberculosis mortality during the first year of life was 8 per cent in non-vaccinated and 0.9 percent in vaccinated children. During the second year it was 3.8 per cent in non-vaccinated and zero in vaccinated children.

Calmette writes, "What doctor, what sanitary authority, knowing these facts and with all the necessary information now available would deliberately refuse to apply this simple method of defence against the most virulent of all human diseases"?

EFFECT OF B.C.G. VACCINATION UPON GENERAL INFANT MORTALITY

In Rumania where more than 80,000 children have been vaccinated, the general mortality since 1927 has been 50 per cent less in the vaccinated than in the non-vaccinated.

In Sweden 4009 infants were vaccinated in a province of North Bothnia; 8343 children were not vaccinated and served as controls. The general mortality has been 2.3 per cent in the vaccinated and 9.5 per cent in the non-vaccinated.

Analogous figures have been found in other countries and cities. It has been observed in France that B.C.G. vaccinated children show a stronger resistance and die less than the non-vaccinated during epidemics of measles, whooping cough or influenza or of gastro-intestinal infections so common to infants.

Calmette and Saenz (1933) state that since the introduction of B.C.G. it has been frequently observed, in both human and veterinary practice that vaccinated children and young animals appear to be more resistant to the usual infantile and calfhood infections than those not so vaccinated and the mortality among the B.C.G. vaccinated children and animals is uniformly less in every country than among the non-vaccinated. They attribute it to the development of what they term a "paraspecific immunity" and believe it to be the result of either the slow impregnation of the central and peripheral nerve cells by the bacterial toxins produced by the B.C.G. which renders the cells less sensitive to other toxins, or to the strong progressive stimulation of the phagocytes free and fixed which allows them to digest bacteria of a lower virulence than tubercle bacilli.

It is stated everywhere that vaccination with B.C.G. reduces the general infantile mortality. This, if further corroborated, would appear to be an additional advantage of B.C.G. owing to the well known high rate of infant mortality in India. Dr. Kostic-Yoksic at the last International Conference on B.C.G. held in Paris in June 1948 stated that children orally vaccinated with B.C.G. grow better than non-vaccinated ones.

WHAT CLASS OF PERSONS SHOULD BE VACCINATED.

Vaccination with B.C.G. may be applied in the first instance to new born infants and also to school children and to all those including adults who give a negative reaction to tuberculin test.

As young babies are very susceptible to tuberculosis and their infection leads to high mortality, Calmette recommended vaccination of all new born babies with B.C.G. He cites the opinion of 280 doctors in Paris, who were consulted, that every viable new born infant should be vaccinated regardless of environment. He states that B.C.G. vaccination has become so widespread in France that in 1932 one out of every five new born infants was vaccinated.

All newborn infants may be vaccinated with B.C.G. without a preliminary tuberculin test because, except in rare instances of intrauterine infection, they are, as a rule, free from pre-existing tuberculous infection.

TUBERCULIN TEST

Tuberculin surveys have to be carried out as a preliminary step to separate the reactors from the non-reactors. In order to get an idea of the incidence of tuberculous infection among the population and to determine the number of non-reactors I have carried out a preliminary tuberculin survey among various groups of population in parts of the Bombay and Madras presidencies, from which a few figures may be cited.

Altogether 51,435 tests were made, of which nearly 24,000 (23,916) were on school children, over 8,000 (8,273) on workers in the textile mills chiefly in Ahmedabad, over 1,000 (1,136) on the police and military personnel of the Mysore and Travancore states and over 16,000 (16,214) in jails of the Bombay and Madras presidencies. The incidence of tuberculous infection found was little over 29% (29.20) in school population, over 41% (41.85) in the police and military personnel, over 46% (46.6) in jail population and over 65% (65.30) in the textile mill workers.

Similar surveys have been carried out by other workers in different parts of India.

For the application of tuberculin the Mantoux test is considered the best because of its accuracy and the precise dosage. As a rule two doses are employed; first dose represents .00002 mgm. of P.P.D. (Purified Protein Derivative) injected intradermally. Negative reaction to this is followed by a stronger dose of .0002 mgm. P.P.D. Non-reactors to this dose are considered suitable for B.C.G. vaccination.

The tuberculin used may be either O.T. (old tuberculin) or P.P.D. The subject must be negative to 100 T.U. (Tuberculin Units). In order to obtain comparable results the tuberculin used must be standard tuberculin. It has been pointed out that in carrying out tuberculin surveys if the material used is not standard tuberculin, varying percentages of reactors among the same group tested can be found by employing different brands which are not equivalent to standard tuberculin, as different brands vary in their potency.

STANDARDISATION OF B.C.G.

The Expert Committee on Biological standardisation (Interim Commission, World Health Organisation) at its second session held at Geneva in March 1948 has considered the question of standardisation of B.C.G. vaccine and states that "supported by our fifteen years' personal experience in B.C.G. culture and by that of scientists of such reputation as M.M. Guerin, Negre, and Boquet-not to mention Calmette-we claim that the B.C.G. strain kept in the right conditions is as stable as can be desired for vaccinating men and all laboratories applying the French technique confirm our claim. Exact rules for its maintenance have been laid down by Calmette and Guerin and we consider it dangerous to break them lightly."

B.C.G. IN SCANDINAVIAN COUNTRIES

A conference convened by the Danish Ministry of Health in February 1946 of representatives of tuberculosis specialists, pediatricians, school physicians, the state serum institute and the general practitioners agreed on launching a campaign for mass B.C.G. vaccination of all tuberculin negative subjects between 7 and 25 years of age with follow-up examinations every fourth year and re-vaccination of all who had turned tuberculin negative. The pediatricians favoured a lower age limit of 2 years.

Norway has recently enacted laws for obligatory tuberculin tests of the entire school population, obligatory miniature 'X'-ray examination of the entire population and obligatory control of all open cases of tuberculosis. The ultimate goal is to make B.C.G. vaccination obligatory for the tuberculin negative population between 15 and 50 years of age.

In Russia oral vaccination of every new born child is obligatory. Cattle are protected against tuberculosis by B.C.G. vaccination in the same way as man.

INTRODUCTION OF B.C.G. IN INDIA

The Ministry of Health, Government of India, after careful consideration of the question of tuberculosis and the method of control by B.C.G. in all its aspects have come to the conclusion that mass vaccination with B.C.G. will be cheap and effective method of reducing the incidence of tuberculosis, which is assuming epidemic proportion at the present moment in the country. It has therefore been decided to introduce B.C.G. vaccination at first on a limited scale in a few large centres under the supervision and control of the Central Government.

The World Health Organisation have already sent a demonstration team to India about the middle of last year to show the authorities the process of manufacture and the technique of administration. The B.C.G. vaccine is being manufactured at the King Institute of Preventive Medicine, Guindy, Madras, and a demonstration field centre has been established at Madanapalle to train up teams of workers in the technique of tuberculin tests and the administration of B.C.G.

Committees have also been set up in certain centres for considering further steps to be taken for introducing B.C.G. and useful work is being done in this direction.

METHOD OF APPLICATION OF B.C.G.

There are several methods of vaccination with B.C.G. *viz.*, (1) Oral (2) Subcutaneous (3) Intradermal (4) Percutaneous or the multipuncture method of Rosenthal (5) Scarification method of Negre & Bretey (6) Respiratory route by B.C.G. aerosol (7) Bucco-nasal administration by spray.

The method largely employed is the intradermal but there are other methods noted above *e.g.*, the multiple puncture method of Rosenthal and the scarification method which in the opinion of the deputationists who submitted a memorandum on B.C.G. on behalf of the Joint Tuberculosis Council and the National Association for the Prevention of Tuberculosis, England, to the Minister of Health, London, "promise to remove the risk of local abscesses which has been one of the most serious obstacles to the general use of B.C.G."

NEED FOR FURTHER RESEARCH

In order to make the application of B.C.G. vaccine more widespread and acceptable and more economical from the point of view of trained personnel at present required for its administration, it will be necessary to develop and improve other methods of application mentioned above or to develop new methods, the object being:

1. to simplify the method of administration so as to make it widely applicable at small cost.
2. to see that minimum inconvenience is caused to the vaccinated subject as a result of reaction following vaccination.
3. to ensure that the necessary number of viable organisms are absorbed into the system to produce maximum immunity.

Other factors to be studied will be:

1. Improvement in the vaccine.
2. Stability of its immunogenic virulence.
3. Improvement in keeping qualities, *e.g.*, by freeze-drying. The Pasteur Institute, Paris, is already studying and developing this method.

In the large scale vaccination to be carried out in this country it would be essential to carry out the work in a most scientific manner. All relevant data regarding morbidity and mortality among the vaccinated as compared to the non-vaccinated groups would have to be collected and carefully analysed. The vaccinated subjects would have to be followed up and their history records kept. In other words, although vaccination with B.C.G. would be undertaken on a mass scale, the work should be carried out with precision and thoroughness of a scientific experiment. Figures collected without necessary details and data will not be useful from the point of view of statistical analysis, with the result that so much work carried out will be lost to science and to scientific experience on which to base future programmes of this important work.

I may just make a passing reference here to another likely immunising agent against tuberculosis—the Vole bacillus vaccine. Its safety has been proved but trials on human subjects have not progressed far.

Limitation of space has prevented me from making adequate reference to several important questions in connection with B.C.G. such as tuberculin tests, value of different methods of applying them, relation of allergy to immunity, duration of immunity, necessity for segregation, criterion for re-vaccination, questions regarding the technical details of its preparation and their importance, precautions and controls and standardisation of B.C.G. on most of which a large amount of literature has been published.

I have hardly touched the fringe of this important subject but the most important thing I would wish to convey is to lend my hearty support to the authorities in their commendable step and to urge them to launch a campaign for the mass vaccination of the population with B.C.G. Given the will and the drive and with proper organisation it will be possible to give protection to several millions of the population in about five years and at a comparatively small cost. With such energetic attack on tuberculosis it is hoped that this scourge which invalidates and saps the energy of millions will soon be brought under control.

Printed by Kalipada Mukherjee at Eka Press, Baranagore , Calcutta.

SECTION OF AGRICULTURE

PRESIDENT: R. S. VASUDEVA, Ph.D. (London), D.Sc. (London), D.I.C.

Presidential Address

SOIL-BORNE PLANT DISEASES AND THEIR CONTROL

I consider it a great privilege to preside over the deliberations of the section of the agricultural sciences and thank the committee for the honour they have done by electing me its President. I am aware of my responsibilities and limitations for the high office and seek your co-operation and active support in conducting the proceedings of the section.

The section of agriculture occupies a very prominent position in the programme of the Science Congress. Economic stability and prosperity of our newly constituted motherland are closely linked up with scientific growth and development of agriculture and we in this section have to play an important role in the work connected with it. It is the national duty of all those concerned with it to strive their best to promote food production at all times to come, particularly in these days of serious food deficit.

The crops must be protected from damage in all possible ways to conserve food if we are to make up the present shortage and avoid famine and ensure consistently adequate supply of it for the country. Losses on this account can be averted by timely application of control measures, and success in agriculture is to be measured by the extent to which food crops can be saved from damage by diseases. In India yields are lower than in other countries even in normal conditions but are further depressed by diseases. The yield per acre in India can be increased by about 10 per cent by preventing diseases. The losses incurred due to various diseases that attack crops in India have not yet been accurately assessed and there are no reliable figures available for this purpose. The only figures available are for the United States of America. The losses in yield caused by the common diseases are recorded for individual States and for the whole of the U.S.A. The average losses during 1930-39 caused in U.S.A. by plant diseases in 12 different crops which are also important in India vary from 6 to 20 per cent, being lowest in grapes and highest in potatoes. The average losses in wheat, maize, cotton and tomato are 10, 12, 16.3 and 16.4 per cent respectively. We in India have a very large number of diseases which cause great losses to our crops.

I wish in this connection to discuss a group of fungi which are soil-borne and are responsible for destruction of a considerable portion of our crops. The subject is fascinating to a student of Plant Pathology and offers a wide field for varied types of investigations including problems both fundamental and of direct application. The subject has not received adequate attention so far in regard to conditions prevalent in India and this is the most opportune time to take up this subject when the crops in this country must be protected in all possible ways. The problems of soil-borne diseases are common over a large area of the world and the methods of control are, therefore, not so variable. The soil surroundings, it is well known, greatly affect the development and spread of such diseases and the environments play a very important role in the occurrence or absence of a disease and disease-causing organism.

Activity of associated soil microflora.—Influence of soil microflora on the development of disease has lately received considerable attention and has come to be realised. Preliminary study of the disease under aseptic conditions with the help of pure cultures is of basic importance for the determination of the causal organism and for the study of the disease in earlier stages, but it is essential to carry the investigation into the field by letting all the natural factors including the micro-organisms play their full role. Investigation with a single pure organism is essential for analysis, but a stage has been reached which requires both analysis and synthesis. We are not getting the full plant pathological story by working with pure cultures of single organisms. It is essential for the investigation of a disease that work with pure culture is supplemented with mixtures of organisms recovered from the diseased soil of the locality in which a particular disease is known to occur.

The routine method followed for establishing the parasitism of an organism isolated from a diseased material is to carry out infection tests with the plants growing in sterilized soil, as such tests conducted on plants raised in unsterilized soil cannot be relied upon because of the presence of other organisms in the soil which may adversely affect the parasitic activity of the organism or accelerate the attack. In this connection work of Porter (1924), Millard and Taylor (1927), Broadfoot (1933), Henry (1931) and Sanford (1926) requires special mention. They have shown that the microflora of the soil may play an important role in keeping down the incidence of the parasitic organism in the soil. The work has been ably reviewed by Garrett (1934, 1938), Porter and Cartor (1938) and Wiendling (1938). Pigeon-pea wilt investigations at the Indian Agricultural Research Institute have shown that the percentage of infection by *Fusarium udum* Butl., the causal organism, is lower when the infection tests are conducted in unsterilized soil as compared to those conducted in sterilized soil. The ten fungi viz: 1. *Rhizopus nigricans* Ehrenb., 2. *Mucor* sp., 3. *Cunninghamella Bertholletiae* Stadel, 4. *Fusarium udum* Butl., 5. *Aspergillus terreus* Thom., 6. *Aspergillus niger* van Tiegh., 7. *Aspergillus amstelodami* (Mangin) Thom & Church, 8. *Rhizoctonia bataticola* (Taub.) Butl., 9. *Alternaria* sp., 10. *Actinomyces* sp., isolated from the soil showed direct antagonistic effect when tested in the laboratory, but two cultures of bacteria, which lie close to *Bacillus subtilis,* exhibited a marked inhibitory effect on the causal organism. The incidence of these organisms as determined by percentage colonisation of straw in the soil varied during the life period of the crop. *Aspergillus* sp., *Alternaria* sp. and the bacteria appear to be dominant during the month of October but there is a marked reduction in their incidence after November. It has been indicated that the bacteria secrete a toxic substance which has been shown to be both fungistatic and thermostable. A large number of examples could be quoted in this connection but the work of Wiendling (1932) requires special mention. He explained the reduced parasitic activity of *Rhizoctonia solani* Kuhn., *Phytophthora parasitica* Dastur and species of *Pythium* and *Rhizopus* on the basis of inhibitory substances produced by *Trichoderma lignorum* (Tode) Harz. Similar results were obtained by Vasudeva while working with an organism which attacks the apple fruit. The parasitic activity of *Monilia fructigena* Pers. is greatly interfered with by the addition of certain fungi such as *Botrytis Allii* Munn (Vasudeva, 1930) to the inoculum. Depression in the parasitic activity was also obtained when the fungus *Botrytis Allii* was replaced by its metabolic products and internal enzyme extract. Vasudeva further stated that in the case of *Botrytis cinerea* Pers. however, increase in parasitic activity was indicated when enzyme extract of *B. Allii* was added to the inoculum. In the case of *Rhizoctonia bataticola* and *R. solani,* the causal organisms of root-rot disease of cotton, he showed that the presence of *Trichoderma lignorum* and *Aspergillus niger* in the inoculum of these fungi greatly interferes with their growth. The hyphae of *T. lignorum* showed a dissolving effect on the hyphae of the parasitic fungi (Vasudeva and Sikka, 1941).

The more important plant pathogens normally inhabit the soil and attack the underground parts of plants. The other soil micro-organisms have an important bearing on the existence of such parasitic organisms and they may even cut down the saprophytic existence of the parasite. It is, therefore, essential to have a full picture of the interrelationship of the parasite and the other soil microflora. The parasitic activity of the organism in the soil depends mostly on the soil environmental factors such as temperature and soil moisture and on the particular type of available food material. It has been shown that if uniform conditions of temperature and moisture are continued to be maintained in the soil, the soil-inhabiting organisms reach a certain state of equilibrium. Any change effected either in the nutritional state or the physico-chemical conditions of the soil such as soil-reaction, moisture, temperature and aeration would upset this equilibrium and appreciably affect the incidence and the type of microflora. With a view to controlling the parasitic activity of such fungi which attack the roots of crop plants by adjusment of the existing agricultural practices it is necessary to gather full information about these factors. A great deal of information still requires to be collected in order to find out whether this check is exercised by adverse conditions directly affecting the incidence of the parasite in the soil or by the antagonistic influence of the other organisms occurring in association with it in the soil. Considerable amount of work has been done on the study of effect of known mixtures in culture media, but the study of the effect of mixtures of organisms on the development of the disease under known field conditions has been rather limited and this aspect of the problem requires extensive research.

The presence of such root attacking fungi is generally associated with their host plants and in the absence of their host plants for long periods they tend to diminish for they are incapable of competing with the saprophytic flora. The development of resting spores and *sclerotia* is a means by which the parasitic fungi overcome this drawback. These organisms spread through the soil, over and inside the underground parts of the host plant. A systematic study for the control of a particular disease of this nature requires a preliminary survey of the soil conditions under which the disease is known to occur. It has been observed that certain diseases can be controlled by reverting to old agricultural practices, *e.g.,* mixed cropping etc. which had been abandoned for one reason or the other.

Modes of spread:—The fungi responsible for soil-borne diseases are specialized and do not under normal conditions multiply on the organic matter available in the soil but can only multiply in the presence of the host plant. The soil microflora consist of organisms of two types: those capable of saprophytic existence in the soil on the available organic matter and the others which are responsible, for attacking the live plant parts. An interesting and most important factor is the spread of such fungi in the substratum from one host to the other which is located some distance away. In the United States of America Taubenhaus and Killough (1923) have demonstrated for *Phymatotrichum omnivorum* (Shear) Duggar, the organism responsible for root-rot of cotton, that it spreads through the soil along with the roots of host plants and from plant to plant by root contact. Padwick (1935) working on "Take-all" disease of cereals in Canada demonstrated that the spread of the causal organism *Ophiobolus graminis* Sacc. was considerable under growing wheat and species of *Agropyron,* whereas the fungus failed to show any appreciable spread in the subsoil when the susceptible crop was absent. Such specialized parasites may be able to thrive in the soil for some time in the absence of the host plant but they can neither multiply nor spread. Their existence, therefore, in the circumstances is cut short, particularly when a large microflora which flourishes on the decaying organic matter in the soil is present.

Soil environments have an important bearing on the occurrence of soil-borne diseases and the soil factors may directly affect the parasitic activity of the disease-causing organisms. It is most likely that the soil conditions also affect the incidence of the disease by influencing the host resistance. While considering the effect of soil conditions, the physical and chemical nature of the soil, soil temperature, soil moisture content, reaction of the soil and organic matter content of the soil require special attention.

Soil texture:—It has been shown that a large number of soil-borne diseases flourish in light soils whereas comparatively few diseases of this type are observed in heavy soils. The fungi which infect roots are known to be highly aerobic and their parasitic activity is greatest in light soils. The water holding capacity of the heavier soils is much greater and consequently such soils maintain a comparatively high humidity in the subsoil, and this also in certain cases proves favourable for a virulent attack of disease. It has been shown that the spread of *Phymatotrichum omnivorum* is greater in heavy alkaline soils. (Fraps, 1936, Taubenhaus et al 1937, Ezekiel, 1938).

The effect of nature of soil is best shown by *Ophiobolus graminis* the growth of which along the roots of wheat seedlings is favoured by well-aerated soils. It has been indicated that the growth of this organism in soils with poor aeration is hampered by the excess of carbon dioxide as a result of its accumulation. This has been supported by experiments conducted in the laboratory in which the sensitiveness of *Ophiobolus graminis* to the presence of CO2 has been demonstrated (Garrett, 1937).

Soil Temperature:—It is known that growth of certain fungi and bacteria is generally favoured by high temperatures. There are, however, some organisms which flourish at comparatively lower temperatures. Wilt producing fungi such as species of *Fusarium* become more virulent as the temperature rises: *Phytophthora infestans,* which is responsible for the late blight of potato and attacks tubers also, is extremely sensitive to variation in temperature. The disease is common in the hills and occurs rarely in the plains of India, as the causal organism cannot withstand high summer temperatures that prevail in the plains. In the plains the disease has been found to occur only in the crop raised from the seed which is imported from the hills at the planting time and has not been previously subjected to high temperatures. Most of our knowledge concerning the effect of temperature on disease is due to L. R. Jones and his brilliant collaborators of Wisconsin (1926). Studies of the disease causing organisms in temperature control tanks along with large scale field observations have provided very useful data on the subject. The periodicity in the activity of the disease during the growing period of a crop, the restriction of a disease to particular regions, and variation in the occurrence of the disease during different years clearly show the part that temperature may play on disease incidence. The root-rot of cotton in the Punjab offers a very good example. Cottons in the Punjab are normally sown in the month of May and the attack starts soon after the first irrigation when the plants are about 4-6 week old. The disease first appears in June and within a fortnight the maximum amount of attack is reached. It continues to be vigorous throughout July. In August the rate of death of plants gradually declines and the disease almost ceases by the end of September. LeClerg (1934) reported 25-33°C. to be the optimum temperature for root-rot in sugar-beet, and Vasudeva and Ashraf (1939) established that the root-rot of cotton caused by *Rhizoctonia bataticola* and *R. solani* is at its peak at 35°C. Tobacco root-rot caused by *Thielvia basicola* zopf. is favoured by comparatively low temperatures and has been found to be severe at 17-23°C. by Johnson and Hartman (1919). They further stated that the incidence of the disease was considerably reduced at 26°C and that at a temperature of 20°C. the disease incidence was almost negligible. *Phymatorichum omnivorum*, the organism responsible for Texas root-rot of cotton, is most active during the season when the crop is in the field because of the favourable temperature. In September and October, when there is fall in temperature there is a corresponding fall in the incidence of the disease. Such reduction in the incidence of the disease, however, occurs rather late in the season to appreciably reduce the losses.

A considerable number of difficulties arise during the study of the effect of one of the environmental factors on the parastic activity of a particular organism, as several other factors combined come into play. The technique has, therefore, to be carefully developed for any individual problem with a view to eliminating all the other factors excepting the one under investigation. A large number of other diseases such as root-rot of corn caused by *Rhizoctonia* and *Pythium*, and root-rot of peas caused by *Aphanomyces euteiches* Drechsler are prevalent at temperatures ranging from 15.5°C.-22°C. It is well known that the smut of onions, *Urocystis cepulae* Frost, thrives in the Northern States of America due to low soil temperatures and the disease seldom occurs in the Southern States except in localities where the crop is raised in the coldest period.

Soil moisture:—It has been observed that the amount of moisture in the soil may greatly inflence the incidence of a disease. There is ample evidence to show that wilt-causing fungi assume an extremely virulent form when moisture content in the soil is high. Monteith (1924) working with club-root of crucifers caused by *Plasmodiophora brassicae* Wor. recorded that the disease appeared in plants maintained at a soil moisture content of 60 per cent or more and that it was not observed to develop in soil with a moisture-content of 40 per cent or lower. Vasudeva (1937) while working with root-rot disease of cotton observed that an adequate supply of moisture in the early part of the season favoured the development of the disease. In experiments conducted under controlled conditions he found that the causal fungi were unable to parasitise at low soil moisture contents. Pontis (1940) has similarly found that wilt in chillies is considerably increased by heavy irrigation and the consequent rise in soil moisture content. Smith and Walker (1941) working with *Aphanomyces* root-rot of garden pea found that no root-rot occurred in an infected soil when its moisture-content was maintained at 45 per cent, while at 75 per cent of water holding capacity the disease incidence rose up to 72 per cent. "Take-all" of wheat and Texas root-rot of cotton are further examples of diseases which require a high soil moisture content and are practically absent in abnormally dry years. It is well known that excessive irrigation may also facilitate the mechanical spread of a soil-borne disease. However, and excessively high percentage of moisture in the soil may tip the balance between the host and the parasite in another direction. Thorp and Young (1939) working on the wilt disease of cotton caused by *Fusarium vasinfectum* Atk. have shown a positive correlation of the disease with a rise in moisture level to 80-90 per cent of saturation, and a negative correlation with increases above 90 per cent.

While a good many diseases are favoured by a reasonably high soil-moisture content, there are others which prefer a low percentage of moisture in the soil. In many such cases the beneficial effect of low soil-moisture content on the disease has been found to be due to increased soil aeration. Sanford (1926) has, thus correlated the enhanced activity of *Actinomyces* sp. with fall in soil moisture content and the corresponding improvement in aeration. Similarly other workers have shown that soil moisture content may adversely affect the parasitism of a fungus by reducing the aeration of the soil.

Soil nutrition relating to disease:—The information available on this subject is so variable that it is difficult to generalise and draw conclusions. Smith and Walker (1941) recently reported that in the case of pea root-rot caused by *Aphanomyces euteiches*, reduction in the severity of the disease was directly proportional to the increase in total concentration of the salts of the nutrient solution used in sand cultures. No infaction was found to occur at the highest concentration whereas all the plants were found to be severaly diseased at the lowest concentration. Alteration in the ratio of N, P and K in the solution exhibited no effect on disease development. The authors further stated that, once the plants got infected under favourable conditions, high concentration of salts did not appear to retard the progress of the disease. Walker and Hare (1943) have also found that in heavily infected soil under favourable conditions for disease, even high applications of complete fertilisers failed to control the disease.

Ample evidence has been adduced by different workers to show that the application of nitrogenous fertilisers tends to increase the susceptibility of a plant to disease, whereas the application of phosphorus and potassium has the opposite effect and increases the resistance of the host. Smith (1944) has reported on the other hand that wilt of tobacco caused by *Bacterium solanacearum* can be appreciably reduced by the application of urea on sandy loam soils. This treatment, however, proved ineffective in soils which were either heavy or had excess of organic matter. In India McRae and Shaw (1933) have reported that addition of superphosphate to pigeon-pea manurial plots at Pusa resulted in a virulent attack of the wilt disease.

A number of diseases such as flag-smut of wheat, *Urocystis tritici* Koern, corn-smut, *Ustilago mays-zeae* (DC.) Cda., bunts of wheat, *Tilletia caries* (DC.) Tul. and *Tilletia foetida* (*Walr.*)Liro. are favoured by the application of organic matter. Diseases like flax wilt, "Take-all" of wheat, Texas root-rot of cotton and potato scab, can, however, be controlled by the application of organic matter. Control of potato scab by the application of green manure was explained by Sanford (1926) on the basis of antagonism of saprophytic bacteria which increase as a result of decomposition of the green manure. King et al (1934) also explained the results regarding the control of root-rot of cotton in Arizona on the basis of antagonism of the soil microflora. On the other hand, Rea (1930) working under dry land farming conditions could not confirm the results obtained by King and his associates under irrigated conditions.

From what I have stated it is apparent that researches on the subject have only indicated that the nutrition available in the soil is one of the important factors to be kept in view while considering the parasitic activities of soilborne fungi. With our present knowledge regarding plant nutrition in relation to disease it is necessary for us to be conservative and not resort to large scale application of the results so far obtained. The results which may appear to be encouraging under a given set of experimental conditions may not give identical results under conditions which are different from those under which the experiments have been previously conducted or under conditions in which the disease appears in a more virulent form. It is, therefore, essential to carry out further investigations along these lines which are likely to provide useful information in the light of which present agricultural practices could be modified with a view to controlling diseases.

Reaction of the soil:—Wilts of cotton, tobacco, tomato and plantain, club-root of crucifers and root-rot of sugarbeet are favoured by soils with acidic reaction, whereas potato scab, pea wilt, "Take-all" of wheat, Texas root-rot of cotton and flag smut of wheat are prevalent in alkaline soils. Some of these organisms are extremely sensitive to soil reaction. The virulence of the causal organisms of "Take-all" and flag smut disease of wheat is increased by liming the soil. As far as "Take-all" disease is concerned the activity of the parasite is directly affected by soil reaction, but in the case of *Urocystis tritici* soil reaction acts only through the host. Potato scab caused by *Actinomyces scabies* (Thaxter) Gussow is more widely distributed in soils with higher pH values than 5.2. In this case the adverse effect of acidity has been ascribed to the direct affect of H-ion on the causal organism. Work of Schroeder and Albrecht (1942) and Gries et al (1944) has shown, on the other hand, that Ca-K ratio is an important factor to be reckoned with in this phenomenon. It has been suggested that one of the effects of the variation of pH of the soil is the alteration of Ca-K ratio by changing the Ca-ion concentration in the soil. An outstanding example of adjustment of pH with a view to controlling a disease has been described by Eddins (1940) in the case of *Bacterium solanacearum*.

responsible for brown rot of potato and other members of *Solanaceae*. On the other hand, Vasudeva and Ashraf (1939) while working with root-rot of cotton in the Punjab found that the incidence of the disease was not affected by change of pH brought about by the addition of sulphur and lime to the soil over a period of 3 years. Thus though enormous data have accumulated to show the close relationship existing between soil reaction and the parasitic life of a soil-borne fungus, there is still need for intensive investigation along these lines in many cases.

CONTROL MEASURES

Resistant varieties:—During the last 30 years or so considerable amount of work has been done on soil-borne fungus diseases and a number of control measures for different diseases have been devised. It is not possible to devise such straightforward control methods for soil-borne diseases as in the case of the diseases of the aboveground parts of plants which can be kept under check to a large extent by spraying and dusting. Fungicidal treatment of the soil on a field scale does not appear to be practicable on account of the cost involved. There is no doubt that the most perfect method for control of soil-borne diseases is the production and large scale distribution of seeds of resistant varieties in a country like ours where the growers are comparatively poor. It is, therefore, obvious that the best method of control is the production of crop plants resistant to diseases combined with other desirable qualities. Evolution of resistant varieties is a long drawn process and involves research for a number of years. Also such a method is practicable when the causal organism is restricted to a single or closely related species. Wherever it has been found possible to evolve resistant varieties the control has been found to be extremely effective provided that during the process of evolution of such varieties, the physiologic races of the causal organism, if any, are kept in view. If this important factor is lost sight of, the resistance of a variety may break down when a new and more virulent race of the fungus happens to make its appearance.

Rotation:—It is well known that most of the serious parasitic fungi cannot multiply in the absence of the host plant. They may persist in the soil for some time, but if the proper host plants are absent their number may diminish and they may in due course even go out of existence. The weakest point in the life history of an organism is the period when methods have to be adopted to attack it. A parasite may persist in the soil on diseased plant debris after the crop has been harvested. In such cases crop rotation is recommended and planting of susceptible crops is avoided with a view to starving out the pathogen. There have, however, been cases where even long range rotation has not been effective enough because the parasite is introduced by other means from outside or carried over by weeds.

Soil sterilization:—Sterilization of soil by means of heat is not a practical proposition as it renders the soil more susceptible to the introduction of the parasite afresh, and once the parasite is introduced into the sterilized soil it does far greater damage than in the case of ordinary soil. Hot weather cultivation and burning trash is, however, a beneficial agricultural practice. The sterilization of soil with the help of chemicals has not been found very effective and, therefore, cannot be recommended for large scale application in the field. A large number of chemicals tested and proved very effective under laboratory conditions have failed to respond under field conditions. It has been found that the chemicals introduced do not penetrate far deep into the soil to be effective enough.

In the cases where the fungus persists in or on the seed, it can be effectively controlled by seed treatment.

Biological Control:—The only possibility, therefore, of getting rid of the parasite is either by starving out the fungus in the soil in the absence of the host plant or its reduction by the antagonistic effect of the large flora of micro-organisms in the soil. It may be possible to bring both these factors into play by modification of certain cultural operations and addition of certain manures. It is essential, therefore, to evolve more effective methods for checking the activity of a parasite in the soil or for eradicating the parasite by enhancing the activity of the other soil microflora. Mitchell *et al* and Clark (1941) showed that the sclerotia of *P. omnivorum* disappeared earlier from the soil to which organic manure had been added. "Take-all' of wheat and Potato Scab have also been controlled by the application of organic manures.

The control of soil-borne diseases in plantation crops is an extremely difficult matter and it is necessary to make sure that the land on which a plantation is to be established is free from any known serious diseases. Plantations are usually established after clearing forests where diseases are generally present, but do not make themselves felt. When the forests are cleared the natural balance is disturbed and, if a susceptible plantation is established in such a locality, it would result in serious losses due to soil-borne diseases. In this connection the results of the Pathological Division of Rubber Research Institute, Malaya, require special mention. The infected trees in Rubber plantations in Malaya are spotted and treated individually and the pieces of infected timber which are the initial sources of infection are eradicated. In Nyasaland, Leach (1937) has stated that in the process of preparation of land for tea plantations, the activity of the fungus *Armillaria mellea* (Vahl) Quel. is greatly increased because of the reduction in resistance of roots of trees which have been felled while clearing the forests. The fungus then becomes so active as to seriously damage the tender tea bushes. Leach in this connection has suggested an interesting method of ring-barking before felling, which results in the increased activity of other micro-organisms, thus keeping down the fungus. Ring-barking results in a low carbohydrate content which is more favoured by the other associated micro-organisms.

Soil Hygiene:—The next method involves soil hygiene. Field sanitation is an important factor in the healthy and vigorous growth of plants. Uncleaned fields constitute a danger to the well-being of plants, as remnants of previous crops in the field very often harbour disease organisms. Crops grown under such conditions become exposed to attacks of diseases and get seriously damaged. A large number of cases of fungal diseases which have broken out as a result of neglect of field sanitation can be cited. Ratoon crops of cotton and sugarcane generally get easily infected by soil-borne diseases. To get rid of diseases that perennate in the crop refuse in the soil, the surest method is to collect all parts of diseased plants after harvest and burn them. On no account should they be thrown on manure heaps, as there is always a risk of introducing a disease to the soil by the use of such manure. Wilt diseases and root-rots render certain fields unfit for growing healthy crops. Gram-blight is carried over from one season to another through the debris which is left in the fields and on the threshing floor after harvest. A large number of diseases of this category can be checked by devoting attention to good cultivation and observing necessary precautions for keeping out infection. Dispersal of the infected material should be avoided with a view to preventing the spread of a fungus in the soil. As diseases may get dispersed during planting operations, by irrigation water, by cultivation operations, by insects etc., it is also essential that diseased material should be eliminated from the field in the first instance.

Most of the root-attacking fungi spread underground in or on the roots of host plants so that the spread in the soil from one plant to another occurs by root contact. The removal of such roots would keep in check the activity of the parasite, but this does not appear to be practicable in the case of annual crops because of the widespread root system of the diseased plants in the subsoil and the consequent difficulty experienced in the removal of every part of an infected root. Rogueing is, however, practised in many cases with beneficial results. In the Rubber Plantations of Malaya successful results have been obtained by rogueing after inspection of individual trees at frequent intervals.

There are methods by which the incidence of a parasitic organism in the soil can be reduced. Keeping the land fallow and planting to non-susceptible crops are good examples. The spread of a parasite may also be checked by planting barriers of non-susceptible crops.

Amendment of soil conditions:—When the crop plants are not grown under ideal conditions they are more susceptible to infection, and amendment of such factors would control the disease. Soil amelioration with a view to controlling diseases includes measures devised to enhance host resistance and adjustment of soil temperature, soil moisture, soil texture and soil reaction. The most interesting examples are root-rot of sugarcane in West Indies (Carpenter, 1934) and browning root-rots of cereals in Canada (Vanterpool, 1935), which have been ascribed to low phosphorus-nitrogen ratio in the soil. These diseases can be kept under check in the field by the application of phosphate. Root-rot disease of cotton in Sudan has been ascribed to poor aeration of roots in heavy soils, (Massey, 1934) so that the susceptibility of cotton is closely connected with the nutrition of the plant. Soil amendment, it is obvious, would directly affect the disease causing organism as well as the resistance of the host plant and the effect of such amendment on the host requires careful analysis. An interesting example of control of "Take-all" disease of cereals consists in the sowing of barley seed mixed with trefoil and Italian rye grass. The mixture grows well after barley is harvested in autumn and is ploughed in during early winter for the preparation of the next crop. The most interesting factor of this measure of control lies in the fact that the actively growing seeds mixture during autumn takes off all the available nitrogen in the soil and thus adversely affects the survival of the causal organism on the diseased debris of the crop. But when the mixture is ploughed in at the end of the growth period, nitrogen is liberated by decomposition and benefits the following barley crop in two ways: by improving vigour of the plants and by elimination of the disease causing organism. This system evolved by Chamberlain and reported by Sylvester and, Garrett and Buddin, (1947), "fulfils two most important requirements for the control of Take-all:" nitrogen low between crops and nitrogen high while the crop is growing".

Under field conditions it is in some cases possible to control the soil temperature by adjustment of sowing time. The object in such cases is to adjust the growth in such a manner that the stage at which the susceptibility of the plant is greatest does not correspond with the time most suitable for attack. An interesting evidence of periodicity in parasitic activity of the causal fungi is found in the case of *Rhizoctonia solani* and *R. bataticola,* the causal organisms of root-rot disease of cotton in the Punjab. The course of the disease clearly indicates that the causal organisms are most active and cause maximum damage during June and July. Cottons in the Punjab are normally sown in May and it has been possible, by shifting sowing period from May either to the first week of April or end of June, to reduce to the minimum the losses caused by the disease. Both early sown and late sown cottons have given satisfactory yields. In the case of late sowings where the plants remain small in size and occupy a smaller unit area the yield is made up by close planting. Another interesting method of controlling the disease by reducing temperature on a field scale has been reported. (Vasudeva, 1939, 1941, 1942). Marked reduction in the number of plants killed due to root-rot was observed in the plots in which cotton was sown in mixture with sorghum. The field temperature was considerably lower in the mixed crop, whereas the humidity was higher. There was, however, no difference in soil moisture contents of the mixed crop and pure cotton plots. Sorghum tended to reduce the yield of cotton in the mixed plots whereas *moth* (*Phaseolus aconitifolius*) when mix-cropped with cotton reduced the mortality from 52.5 per cent to 0.8 per cent in the mixed crop and also gave an appreciably higher outturn. Both soil and air temperatures were lower in the mixed crop whereas the humidity was higher. It was observed in the case of mixed crop with *moth* that if a bare patch was left in the field where *moth* did not germinate, the cotton plants were attacked by the fungus resulting in their death, proving thus the necessity of ensuring a uniform spread of the *moth* crop to cover the soil and thereby control the disease. In another set of experiments where small millets. *e.g. Setoria italica* and *Panicum colonum,* had been intercropped with cotton, there was no material difference in the soil and air temperatures in the mixed crop, but all the same, mortality due to root-rot was lower in the mixed crop than in the pure cotton crop. It is obvious, therefore, that while temperature is probably a very important factor there is some other factor also which comes into play and helps in reducing the incidence of the disease. It is likely that it is the resistance of roots of small millets which act as a barrier in between the susceptible cotton rows and adversely affect the rapid spread of the causal organism in the soil. "Take-all" of wheat, seedling diseases of cereals and certain other diseases can also be controlled by adjusting the date of planting. The case of tomato spotted wilt requires special mention. The virus has a thermal death-point of 42°C. and, therefore, during the cool season the disease may assume serious proportions and severely affect the crop, but when the temperature begins to rise the affected plants recover and do not exhibit any signs of the disease.

In the study of temperature relationship of the parasite and the host it has yet to be determined whether temperature directly influences the pathogen in bringing down its parasitic activity or in some form or the other affects the resistance of the host. This aspect of the question requires much further investigation.

The diseases favoured by high soil moisture can be controlled by modification of cultural operations with a view to improving the drainage of fields and also by adjusting the depth of planting. The tilth of seedbed and aeration can also be adjusted according to the particular problem by variation in cultural operations. A comparatively compact seedbed appreciably controls the "Take-all" disease of cereals caused by *Ophiobolus graminis* which is known to be favoured by soils of light texture. When the disease is favoured by certain types of soils, as for example in the case of Panama disease of bananas caused by *Fusarium cubense* which is more active in light soils, the parasitic activity of the causal organism can be kept under check by growing the crop on land which adversely affects the activity of the pathogen.

A large number of parasitic organisms can attack the crops over a wide range of *soil reaction*, but the activity of some of the organisms which are sensitive to soil reaction can be controlled by adjustment of the reaction of the soil. A good example is the control of Potato Scab by the addition of sulphur with a view to acidifying the soil. Similarly club-root of crucifers which is favoured by acidic soils can be controlled by liming. These methods of changing soil reaction to the required limits are not, however, always practicable on economic grounds. Obviously, in the case of soil-borne diseases, as in most other diseases, "prevention is better than cure".

In the foregoing account of soil-borne diseases I have indicated their nature and life cycle giving the lines on which control measures may be adopted. It will be realized that while some of them are responsible for serious and wide-spread damage to crops, they are extremely difficult of prevention. Special technique and treatment are to be developed for dealing with them. Some investigations carried out have disclosed several obscure features of these organisms and raised new problems, creating a field of specialized research. It has grown into a complicated phase of applied mycology and is to be formed into a separate study of Soil Pathology. Injury is done to the crops from seedling stage to the stage of maturity. It will be noticed that every one of the farm or garden crops is exposed to the attack of one or the other type of soil fungi.

The subject has gained importance during recent years and it having attracted the attention of pathologists, offers hopeful signs of solving the diverse pathological problems. I would, therefore, invite all those interested in the subject to pursue the investigations and make their contribution to mitigate economic losses. For a proper study of these problems team work of pathologists, soil chemists, crop physiologists, geneticists and agronomists is what is imperatively needed to combat such maladies.

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SECTION OF PHYSIOLOGY

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THE PLACE OF PHYSIOLOGY AMONGST THE MODERN SCIENCES AND THE IMPORTANCE OF ITS STUDY TO THE NATION

I wish, first of all to take this opportunity of thanking you for giving me the honour of presiding over the deliberations of the Section of Physiology this year. It is an honour I deeply appreciate, and I fondly hope that whatever shortcomings I may personally have, will be more than made up by your active co-operation in the work of the session.

SIGNIFICANCE OF PHYSIOLOGICAL STUDIES TO MAN.

I have chosen for my address a subject, which is of great interest to all of us and which will in near future be required to solve many vital problems for the new Indian Nation. Extensive studies and researches in Physiology will be necessary, not only for successful tacking of the many problems of diseases in India, but also for maintaining and improving the human factor in all the branches of national activity. The urgency of giving impetus to the study of Physiology and of instituting intensive researches in the subject in this country, has long been felt by many of us. Four of my predecessors in the chair had selected one or the other aspect of this subject for their addresses.

Col. S. L. Bhatia, presiding over the session just after its inauguration, remarked that the recognition of Physiology, as an independent Science of fundamental importance, with a separate section of its own, though tardy and belated, is a distinct and vital landmark in its history in India. He stressed the need of intensive studies and research in pure and applied Physiology. Professor N. M. Basu pleaded to the physiologists and the biochemists for stimulating researches in the subject and appealed to the Government and the Universities for help. Dr. B. Mukerji pointed out the necessity of its development, while pleading the case for Pharmacology; while Dr. Basir Ahmed wanted to see more attention given to the development of biochemistry.

The time has come to us, the physiologists in free India, to make determined and serious attempts to translate our views into accomplished facts. "Only liberty causes Science to bloom, and minds to put forth their full strength", said Grnudling about two hundred years ago and subsequent centuries have only proved this. It is fitting that we should talk, as we are talking now, in this distinguished and representative gathering of physiologists, when extensive reforms are being undertaken in every sphere of our activity.

The importance of Physiology as a special subject of study and research, apart from its position as the basic science for medical studies, is due to the fact that there is scarcely any activity of man, which is not the result of physiological reactions and adjustments and do not require any consideration of physiological principles. We are now thinking in terms of planned activity in the development of Education, Industry, Commerce, Agriculture and other spheres of human endeavour for raising India to the peak of her achievement. Children in our homes and in schools and colleges must develop properly, which mean, among other things, according to physiological standards. They must grow up as healthy individuals with superior mental and physical powers. Men working under diverse conditions, in homes, in fields and factories, in pits and plants, or at desks and departments should be capable of putting forth their maximum with minimum fatigue. Aviators rushing through rarified atmosphere at high altitudes, divers working under pressure in the depth of the sea, or soldiers and sailors fighting under the most exacting conditions, should all be able not only to attain but maintain a high level of efficiency. Our existence as a nation will depend, as much in keeping up the normal efficiency of the human factor or even raising it, as on the improvement in our Educational, Economical, Industrial, Agricultural, Social and other organisations.

Physiology is the study of the normal working of the delicately adjusted systems and of the various factors, belonging both to the internal and the external environments, which influence and modify their activities. If we knew how these factors work, it will not only be possible to bring them back to normal, when deranged in disease, but they could also be regulated to enable the systems to work with maximum efficiency. Thus the knowledge of sex differences and sexual characteristics are no longer hedged round with myth and taboos; it is no longer a mystery. These are matters inviting examinations and explanations and are expressions of physico-chemical forces, to be understood, copied and controlled. In a gathering of physiologists, it is unnecessary to dilate on the importance of physiological knowledge for the health and welfare of man.

I shall now try to indicate a few lines along which we should proceed to improve and develop the study of Physiology and intensify research in the subject.

CLAIM OF PHYSIOLOGY FOR BEING CONSIDERED AS AN INDEPENDENT SCIENCE.

The first essential point to be realised is that Physiology is an independent subject of study by itself, resting on the tripod Morphology, Physics and Chemistry. It is true that the growth of Physiology is inseparably connected with that of Medicine, which incidentally is the mother of all Natural Sciences. But Physiology is not a branch of Medicine, though it forms one of its principal basic subjects. Neither it is a branch of Physics, nor of Chemistry, although Biophysics and Biochemistry form considerable portions of physiological knowledge. This has been repeatedly pointed out by many eminent physiologists, both medical and non-medical, all over the world. We in India have not fully realised this and have not seriously attempted to put Physiology in its rightful place amongst the major sciences. A basic science like Physiology cannot develop if it is tied to the apron strings of Medicine, as one of its various specialised subdivisions. Physics, for example, would have been in a poor subordinate position today if it was treated as a branch of Engineering.

As an independent science, Physiology must be given a prominent place in the University along with Physics, Chemistry, Botany, Zoology and other basic subjects. It should be provided with every facility for higher studies and researches, and must not be treated merely as just one of the subjects for the medical course. Proper recognition has been given to Physiology as a fundamental subject of study in almost all the universities of England and America, and Physiology has flourished most in those institutions, where it had an independent existence like other basic sciences. As an independent science it can claim amongst its votaries many eminent non-medical physiologists, including biochemists, biophysicists, pharmacologists, nutritionists, as well as medical men specialised in the subject. A considerable section of reputed physiologists on the staff of the different universities, colleges (including medical college) and research institutions in Britain and America is composed of men who have no medical degree. Many of these are heads of departments, including a director of a medical research institute. Even the majority of the physiologists on the staff of the British Medical Council Research Organisation are non-medical men.

To give full facilities for the development of the subject "we must avoid like poison the tradition that no man can hold any place of importance in Physiology, unless he has a medical degree;" as Prof. A. V. Hill so forcefully stressed. If the universities in the West had not followed this principle, Physiology would not have been able to give to the world such masters of the science as Pasteur, Langley, Cannon, Bayliss, Lusk, Keith Lucas, Krogh, Hill, Haldane, Hopkins, Gotch, Moore, Plimmer, Drummond, Burger, Stanly Kent, Burns, and Cameron, to name only a few. Some of the greatest discoveries in Physiology in recent years have been made by men who had no medical training whatsoever.

What I want to emphasise here is, that in our country, Physiology has also to be viewed and fostered as a fundamental subject of importance. It should be developed on proper lines, like other independent science subjects. If only Physiology could be placed on its elevated pedestal we could then take our rightful place, with the workers of the other branches of science, as pathfinders and pioners of an advancing civilisation. It is to be remembered that in studying Physiology man has turned from the adventurous conquest of his environment to the conquest of himself.

Fortunately we have already made, though belated, a start in this direction, and some universities in this country have introduced Physiology as a subject of study for the I.Sc., B.Sc., and the M.Sc. courses under the Faculty of Science, and are conferring the degrees of Ph.D. and D.Sc. to the research students in the subject. But the number of institutions teaching higher Physiology is quite insufficient to meet the need of such a vast country as ours. Medical colleges, science institutions, military and aviation schools, research organisations, and pharmaceutical concerns manufacturing hormones, vitamins and drugs, will require a large number of specially trained physiologists.

We, the physiologists in India, have not succeeded in achieving that amount of importance, by our endeavour and work, which have been done by the students of some other branches of Science. Physics and Chemistry form the solid base, along with morphology, on which Physiology rests.

Fortunately for this country, these bases have become strong and are rapidly becoming stronger. This will help in making advanced studies and researches in Physiology highly productive.

As in the other parts of the world, Physiology as a scientific subject has entered the field rather late, and the physiologists have the reputation of being bad advertisers of their wares. The world is moving fast, and we have to make rapid headway to keep up the pace.

Men, by their knowledge and subsequent conquest of many aspects of nature, have introduced conditions, which humanity had not to face before. Thus in the atomic age, we have to take serious notice of the forces and energies, liberated by atomic fission, which are sure to have a profound influence on the activities of the living organism. This is being done by other countries, and we have to take them up also.

For steady progress Physiology will require properly trained teachers, research workers and specialists, who have had an advanced post-graduate training in the subject under competent teachers in suitably equipped institutions. India is setting her house in order in every sphere of life, and this is the appropriate time when her physiologists should make determined effort to lift up their subject to its elevated place in the domain of Science.

PHYSIOLOGY AS A SUBJECT OF STUDY IN MEDICAL CURRICULUM.

It is superfluous to point out the importance of the application of the knowledge of Physiology in medical practice. It is one of the basic subjects of study for all medical students. They must be thoroughly familiar with the physiological principles, morphological, biochemical and biophysical, which are responsible in keeping the organs working normally. This will form the solid foundation on which their future clinical knowledge will be built up. No effort should be spared to make this foundation stronger by improving the teaching of Physiology as far as possible.

During recent years educationists in England and elsewhere discussed the ways and means of achieving this. It is a vast subject with intricate details based on structural changes and physio-chemical principles. It is not possible to treat Physiology in its entirety within the time allotted for its study. Yet it forms the solid base on which the future medical knowledge of the student will rest. A via media should be followed and the students given a fairly comprehensive knowledge of the subject, without going into unnecessary details. Their physiological education must fit in with what they are to learn in their clinical studies later on.

It has been a disputed point whether students should be taught at every stage the abnormalities and the pathological condition of the systems, along with their normal physiology. Should they be taken to the hospital to study, for example, the different types of cardiac diseases at the bed side, while just learning about the contractions of the heart and the various factors which regulate it? We must remember that students get just two years to complete the study of Physiology and a considerable portion of this period has also to be set aside for the study of the equally important subjects of Anatomy and Pharmacology. It will be difficult to include extra classes outside the laboratory, without seriously interfering with the periods of study in the other subjects. Moreover, it seems to me that the explaining of abnormalities of the function of an organ becomes a difficult task, when its activities are materially influenced by other organs and systems. Medical students must have a clear knowledge as to how the delicately balanced human system, with the various tissues and organs constituting its different parts, works. They must know how this balance is maintained, inspite of wide variations and frequent fluctuations, before they can understand what happens when this is upset in disease. The systematic study of Applied Physiology can be continued with evident advantage, during the subsequent years in their clinical classes and in their post-graduate studies.

Apart from these considerations, every teacher in Physiology feels that there is considerable scope of improving the teaching of the subject. In teaching a science like Physiology, where various complicated factors, morphological, biochemical and biophysical are responsible for functional activity, it is necessary to take the help of actual demonstrations to explain these clearly. In these demonstrations the different factors can be regulated and controlled and a very clear idea of their action is indelibly impressed on the minds of the students. Neither the best text books nor the most efficient teacher can achieve this. I think it is possible to improve the teaching of Physiology by incorporating regular periods of demonstration classes, where essential principles of circulation, respiration, alimentation, excretion, nervous system and sense organs can be easily illustrated and explained. If unalterable timetable is an obstacle for finding sufficient periods for these classes, a few theoretical lectures may be sacrificed and in their places demonstration classes incorporated. After all both are meant to achieve the same end.

It is true that practical classes have been introduced to make students familiar with some typical methods of physiological investigation and technique. But with large batches of inexperienced students, and within the period that can be allotted for these classes it is only possible to undertake simple and easily conducted experiments. Yet I am sure we can think of and attempt some improvements. For example, some simple experiments can be introduced on circulation and respiration, such as, the influence of exercise and carbon dioxide on pulse and blood pressure, and on the volume and rate of respiration. We can give the students additional knowledge on blood by incorporating experiments on coagulation time, on mean corpuscular volume and haemoglobin content, and on bleeding time. They may even be asked to do a few easy experiments demonstrating reflex activity and activities of sense organs.

A few suggestions have been put forward for improving the teaching of Physiology. It is a recognised fact that well qualified teachers are the prime factors in good teaching. In selecting the staff only those who have specialised in Physiology, by taking additional courses of study in the subject, should be chosen. Their advanced and critical knowledge of the subject, both theoretical and practical, will be an asset to the department. This service cannot be expected from graduates whose experience is limited to a couple of years' training in the junior course of the subject, in their preclinical studies.

I may be allowed to suggest that, when we are preparing plans for improvement in our education for the proper training of high class scientists and technicians, immediate steps be taken for carefully preparing plans for the improvement of the medical curriculum. In recent years Physiology, specially biochemistry, has made a tremendous progress and the education of the modern students may remain incomplete if some of the outstanding results are not included in their studies. But there are sure to be indifferent or not so intelligent students in the class, for whom a simpler course is indicated. The teaching of the subject in additional details will be appreciated by the more intelligent and ardent of the boys and they will be much benefited by it. It is not a bad idea to provide additional courses of study in Physiology, of a higher standard, for those students for another year, enabling them to secure honours in the subject. Many students in the universities in Britain and elsewhere, where such facilities exist, take advantage of this arrangement.

Those of us who are closely associated with the teaching of Physiology, should give their serious attention to these matters. We should not be afraid, if necessary, of introducing far reaching changes, by changing the permutations and combinations, instead of merely adding to or deducting from the present curriculum.

PHYSIOLOGY AS A SUBJECT OF STUDY UNDER THE FACULTY OF PURE SCIENCE.

Modern physiologists are more than men practising medicine and devoting their attention principally to the abnormalities created by diseases. They are just as much interested in the study of the factors controlling the physical efficiency and the working capacity of individuals, under various conditions of stress and strain, imposed by modern civilisation. They are anxious to find out in detail, with the help of the advanced knowledge of Physics and Chemistry, the intricate mysteries of the deeply hidden delicately adjusted and intimately correlating organ systems. With this knowledge they hope deliberately to regulate and improve the human machinery. Like other sciences Physiology is rapidly passing from the early phases of scientific investigations into the stage where nature is copied and improved by synthesis. A survey of the research work done by physiologists in recent years will make this point clear.

Important advances have been made in Biochemistry, Biophysics, Pharmacodynamics, Physiological aspect of Genetics, Physiology of Growth and Development and of Reproduction. Recent studies of the Regulation of Body Temperature and maintenance of efficiency in extremes of heat and cold, of the Physiology of Exercise, and of Industrial Physiology have advanced considerably our knowledge regarding the working capacity of man. These are just a few instances of some of the more important problems in Physiology, the solution of which our Indian Scientists have to undertake and the too at no distant future. They will be urgently needed if we have to maintain even a minimum standard of efficiency amongst the nations of the world.

For tackling these problems India will require bands of trained physiologists,—physiologists specially trained in the theory and practice of some of its highly specialised technical branches. Proper arrangements have to be made for turning out sufficient numbers of such scientists.

Physiology in Schools

To begin at the very beginning it has to be decided whether Physiology should find a place in school and college curriculum. To do this one has to realise its significance as a biological subject of general education. There are strong arguments in favour of considering Physiology as the most important of the biological subjects. Students of science know the difference between monocotyledons and dicotyledons or between the different classes of animals. They know about the composition of water or the nature of light, but have only a vague idea as to how the heart works, the stoppage of which is the end of themselves. Even grown-ups often emphatically say "my liver is upset" but have no idea of the liver and its functions and fail to realise the importance of expert help in putting such a complex organ in proper working order. It will certainly be of great advantage to people if they knew something about the working of their own bodies, which form the basis of healthy living.

There is no reason why Elementary Physiology, instead of Hygiene, which is taught in an empirical manner, should not be introduced in schools as a compulsory subject of study. Children should be taught the physiological basis, which gives reasons for the habits to be inculcated, to put them on a sound foundation. Physiology is a subject particularly alive, not only because it deals with living but also because it creates interest in one's own body and its working.

The British Association at their meeting at Nottingham in 1937, held a major discussion on "Physiology as a subject of General Education", in which many prominent physiologists gave their considered opinion from different aspects and earnestly appealed for introducing the study of the subject in schools and colleges as a pure science. Apart from other things, they stressed that through a better understanding of the functions of the human body, habits of healthy living may be established, which would result in raising the general level of health and physique of the people.

There are some educational organisations in India, where simple Elementary Physiology and Anatomy are taught in schools as a compulsory subject. But it should be included in the curriculum of all school education in India, as has been suggested in the Wardha Scheme of Primary Education.

Physiology in Graduation Course.

For proper teaching of Physiology, it is, however, essential that students should have some knowledge of Physics and Chemistry. As such, the correct procedure will be to teach Physiology in colleges, along with other science subjects. The curriculum for the graduation course should not be much different from the preclinical physiology course. Only those who take up honours will be required to study the subject in much more intimate detail. Such a course of study is in existence in almost all the Universities in other parts of the world. Calcutta University introduced this subject for their pure science course, nearly forty years ago, and a vary large number of students have taken advantage of it. It is a very popular combination for the B.Sc. course with other subjects like Physics, Chemistry, Botany, Zoology, Anthropology, and Psychology. The advantage of combining the study of Physiology with Physics and Chemistry or with Botany and Zoology or with Anthropology and Psychology is self-evident. All the institutions teaching Physiology have to refuse admission, each year, to a very large number of students, for want of sufficient accommodation. These students, after graduation either join the Medical Colleges, where their knowledge of

Physiology together with other science subjects, is of great help or they take up Post-Graduate studies in Physiology and Biochemistry, in Botany, in Zoology, in Anthropology or in Psychology.

The observations made regarding the improvements in the method of teaching in medical institutions are also applicable here. Both the courses should be planned and taught in the same standard.

Physiology in Public Service Examinations

Physiology formes an important subject of study for the Indian Civil Service, as it does in the British Public Service Examinations. Of the subjects the future administrators have to study, a knowledge of Physiology will come most handy in a practical way, specially in connection with the health and physical welfare of the people amongst whom he will be working. Quite a large number of Civil Service men had Physiology as one of their subjects of study and every one of them freely admits this advantage, to be of real value.

POST GRADUATE STUDY OF PHYSIOLOGY.

No science can develop without highly trained and ardent votaries. In the first half of the 19th century, Germany and France were far ahead of England with their contributions to Physiology. The reason was that no one took up pure Physiology as a vocation. Any physician or surgeon was considered competent to teach the subject, and England had not produced a Johannes Muller, Carl Ludwig or Claud Bernard, savants who had devoted their entire life and energies to the study of the subject. It was only when William Sharpey became Professor of Physiology in the University College, London, and stimulated advanced study of and research in the subject, by collecting a band of earnest workers, that the Modern School of Physiology in England was founded.

India must have highly qualified physiologists, who have been given every facility for becoming real masters of the subject. Students who have completed their preclinical course, or those who have graduated in pure science with Physiology, after all go through a junior course of training in the subject. The honours standard is certainly much higher and the subject is taught in greater detail, still these students cannot be considered to have gained an intimate knowledge of the subject, nor are they sufficiently familiar with many of the modern methods of critical investigations in Physiology. They can only acquire such knowledge in their Post-Graduate course, where apart from their theoretical studies, they have to devote the major portion of their daily working hours, in being carefully trained in the latest methods of physiologycal investigations under compenent teachers specialised in its different branches.

Meritorious students who graduated with Physiology, whether from the medical colleges or from the science institutions, should be encouraged to take up Post-Graduate studies for specialising in the subject. There is an extensive and profitable field of work for Post-Graduate scholars and research fellows. The need of well trained physiologists is admitted and their paucity has been acutely felt by all interested in the subject.

The Post-Graduate Laboratories must have all the equipments they require for teaching and research in Histology, Biochemistry and Biophysics. The existing laboratories should be enlarged and greater facilities created for critical research in both Fundamental and Applied Physiology, to turn out sufficient numbers of specially trained men without delay.

The Post-Graduate curriculum should be so arranged that the students are given a detailed and intimate knowledge of the subject in all its departments, with intensive training in some special aspect of Physiology. India need really good histologists, biochemists and biophysicists. In planning the development of Physiology, the advanced study of and researches in all its branches must be included. The majority of the students, who are admitted to the Post-Graduate studies, have completed their honours course, and it will be a pleasure to take them critically and exhaustively through the intricacies of structure and function.

The practical work for the Post-Graduate students should be such, that they are given a comprehensive training in all the departments of Physiology. As in the case of the theoretical side, these students will have to select some branch of the subject for specialisation, in which they have to undergo a further course of intensive and detailed practical training. The Post-Graduate students will have enough time to learn to conduct complicated animal experiments on circulation, respiration, excretion, nutrition, metabolism, sense organs and nervous system. They will have ample opportunity of carefully preparing histological specimens by special microanatomical and cytological methods for examining the minute structures of all the tissues and organs of the body and their variations. Their knowledge of biochemistry will be considerably strengthened by learning to isolate and correctly analyse the different biological products by the most uptodate methods and to properly assay the activity of the different enzymes, hormones and other biological catalysts.

Calcutta University made a move in this direction in 1912. The need of instituting higher studies in Physiology in this country, become apparent to that clear sighted visionary, the late Sir Asutosh Mookerjee, and the Post-Graduate course in Physiology was inaugurated in that year under the Faculty of Science with Prof. S. C. Mahalanobis as the Head of the newly created Department. The Department has steadily grown and has turned out a large number of M.Sc.'s and a few D.Sc.'s in Physiology. Almost all of these scientists have gained prominence as teachers, research workers and specialists. The subject is very popular, and each year a good few graduates have to be refused admission for want of sufficient accommodation. There is an urgent need of well equipped Post-Graduate Departments all over India to meet the growing need of higher studies and researches in the subject in his country.

RESEARCHES IN PHYSIOLOGY.

Investigations in Fundamental Physiology.

Extensive researches in Physiology must be undertaken, not only for the development of the subject, but also for the solution of many urgent problems for the benefit of mankind. Every physiological laboratory in the country, whether in medical colleges or in science institutions, should provide for the advanced study of and researches in Physiology. They should secure the latest types of apparatus or construct others themselves. A large part of this work will naturally be undertaken by the Post-Graduate Departments, and the nature of work that will be taken up will depend mainly on the personnel of the staff and the subject of their special training.

Important physiological researches are being carried on in the different physiological and biochemical laboratories in India, but the scope and the volume of these are far below the desired mark. All kinds of researches should be encouraged, whether in fundamental or in applied Physiology. Often it is difficult to separate the two. As a matter of fact, we can scarcely think of any function of the body, which has no application in every-day life.

Researches in Fundamental Physiology are the bases on which Applied Physiology will grow and develop. There are so many aspects of research in this subject that it is not possible to dilate on this in an address. Physiologists are discovering every day new and interesting facts regarding almost every organ and its functions.

There are many problems on the applied side of Physiology, which call for immediate attention. I may be allowed to cite a few instances to make my point clear.

Physiology of Growth and Development

Physiology of growth and development and the physiological aspect of genetics should be subjects of special interest to Indian physiologists. Plans for future progress in all directions are being instituted everywhere, and it is the generations yet to come who will benefit most from it. For their sake, clear ideas of the various factors controlling growth and development should be available for scientifically regulating, under the conditions existing in our country, their physical and mental progress. This will help to produce properly developed and physiologically balanced individuals, with the solid base on which his or her future activity and fruitful life can be built up. Various factors including heriditary, endocrine, nutritional, climatic and other environmental, incidental to the country, have to be studied and their bearing on this problem determined.

Physiology of Reproduction.

Physiology has taught us how profoundly the sex organs influence the entire outlook of life in men and women. Gynaecologists can bear evidence and supply data of how much our women folk suffer from the effects of maladjustment of this important system. They are doing their level best to remedy the mischief that has already started in their patients, mischief which could have been avoided. There are various factors, endocrine, dietary including vitamins, climatic, physical condition and fitness, exercise and personal habits, which influence these organs and their internal secretions. These have to be studied, under the conditions prevailing in our country and in our society, and the results utilised for maintaining the normal physiological activity of the organs of reproduction. The sex hormones influence the happiness of individuals by its action, not only on their general health, but also on the impress of manliness or womanliness on their physical and psychological make-up and thus on their contented outlook on life.

The world population is increasing steadily and we are just beginning to realise the importance of the study of sexual activity and reproduction and the limits of potential span of life, in its effect on the density of population.

Physiology of the Regulation of Body Temperature.

Man is supreme as a homotherm, but at a price. The physiological mechanism of temperature regulation, which plays such an important part in influencing the physical fitness and the working capacity of the individual, should form a profitable item of research with us. This naturally has a bearing on Industrial Physiology and Hygiene, and may be considered as one of the factors in influencing production.

Attempts should be made to institute suitable researches on this problem, under the conditions prevailing in this country, to determine the factors, both intrinsic and extrinsic, which help in maintaining optimum temperature for the efficient working of the system. During the last war it was proved that with proper adjustments men can live healthily and work efficiently under trying tropical conditions.

An example can be considered here with an interesting and highly practical appeal for every individual, I mean the Physiology of Clothing. Clothing should be comfortable, serviceable, cheap and must satisfy our highly developed aesthetic sense, but above all, it should primarily be suitable for helping to maintain the physiologically optimum temperature of the wearer.

A considerable number of situations call for highly specialised clothing. These require the study of prevention or acceleration of heat loss, under these conditions. The industrial worker working under different and often trying environment, the soldiers fighting in the open, the aviators rushing through space, require their clothing adjusted to their particular needs. In the laboratory the assessment and the comparison of fabrics on a physiological basis is a practical proposition, particularly with the data provided by the newer studies of thermal regulation in the human subject. We have already started agitating for reform in our dress, but we must take every precaution to see that the dress chosen is also physiologically suitable.

Aviation Physiology.

Physiologists have materially helped in making the high speed and the high altitude flying possible. Nature did not adapt the human body for such work in this kind of element. The brain, the sense organs, the respiratory and the circulatory systems are all profoundly affected by the sudden changes in the atmospheric pressure and the considerable pressure changes created by the high centrifugal force in diving and turning. The result is sudden blacking out, loss of judgment, and perspective, flying fatigue, hetrophorus and other depressing conditions. In the early years many serious accidents did happen to pilots being affected by these. To make high speed and high altitude flying possible the physiological efficiency and working capacity of the air crew must be maintained.

Physiologists were approached and were asked to solve these complicated problems. The first World War was rapidly approaching and the nations knew that they must use this new important branch of defensive and offensive weapon to the fullest extent possible. Batches of physiologists working steadily in laboratories and high up in the air, with ingeneous apparatus and gadgets, succeeded in studying the alterations produced in the physiological working of the system, and devising means of successfully overcoming or preventing them. Taking off or landing at high speed was made possible, in spite of the tremendous stress it imposed, and distortion was no longer a factor to cause flying through cloud and fog unsafe. The help of physiologists were even utilised for the designing of airplane. The modern design of bomb sight, lightening of cockpit and the arrangement of the instruments on the board, eliminating ocular fatigue; designing of the flair for night landing, to facilitate optical adaptation, are amongst others the products of physiological laboratories. There was still further advance in the speed of locomotion, during the Second Great World War, and the physiologists had again to play their part in looking after the human factor.

Independent India should give serious attention to this vitally important problem. She cannot certainly afford to neglect her aerial defence and the safety of her life-lines through air. Some of the physiological laboratories should be specially fitted up with pressure chambers and other necessary apparatus for training and research in Aviation Physiology. This should be undertaken in co-operation with the Air Force or the aviation schools.

Stratosphere is looming large as the future path of rapid travel, but it is beset with many practical difficulties. What part India will play in perfecting this ultra-modern mode of travel, will depend also on her physiologists, who will have to solve the most important of the problems, that of the human factor.

Similarly, the investigations of the special problems, arising out of the conditions, in which the army and the naval personnel may be required to fight for the defence of the country, have also to be undertaken. The human factor is very important in war. Not only elaborate arrangements have to be made for treating the ailments and the war injuries of the fighting forces, but also the physical efficiency and the capacity for work have to be maintained, and, if possible, increased under all conditions, however trying.

Pharmacodynamics and Physiological Standardisation

India has to depend on herself for her supply of drugs. Many eminent pharmacologists have wholeheartedly taken up this work in well equipped laboratories, but the field is large. A considerable amount of work has to be undertaken for the isolation of the principles and the determination of their chemical composition. After which these have to be tested for their activity and standardised. A large number of properly trained scientists will be necessary for this work. The physiological laboratories can render active help in this direction by undertaking the training of students in pharmacodynamics and physiological standardisation and critical researches in the subject. This is a profitable field of work and the post-graduate students of physiology, who have learnt to conduct experiments recording the variations in the activity of different organs of the body, will be able to undertake these investigations. The experimental physiologists will also be able to help in this matter by devising suitable methods for standardisation. It is the experience of many that the method of physiological standardisation followed by the western scientists have to be modified to suit Indian conditions and experimental materials. Thus the physiological laboratories in India can render valuable help to the drug industry.

Investigations with Electroencephalograph

Studies with Electroencephalograph is gaining prominence as a promising field for investigation on brain. A very useful method has been placed in the hands of physiologists for determining the state of cerebral activity in intact animals and in man himself. The results obtained are very encouraging and promise to solve many complicated problems in the working of the human brain in normal and pathological conditions. Perfection of this method of study will place a powerful weapon in the hands of neurologists. The physiological departments in this country should be helped to start research in this important branch of investigation.

Physiological Effects of Radiations.

With the unfolding of the mysteries of atomic energy, an extensive and fruitful field of research has opened up for physiologists. Living cells with their quota of delicately adjusted energy reactions must be profoundly influenced by these high penetrating rays, with immense energy values. The study of the physiological effects of alpha, beta, gama, neutron and other rays are sure to be of considerable practical value, not only in medicine but also in other spheres of activity. Researches conducted with these rays have already shown their important action on blood and haemopoetic organs, on immunity and on the production of carcenomas.

With better knowledge of these radiations it will be possible to devise methods, which might prove effective in protecting the workers and others exposed to these. This will be badly needed by those engaged in work with these rays. It has been estimated that more than 3000 persons died in Japan from the effect of irradiation alone from the bursting of two atom bombs. For conducting research with these radiations the active co-operation of the Department of Atomic Physics will be necessary.

Industrial Physiology.

As in the case of airmen and the fighting personnel, the health and efficiency of workers, who form the backbone of the industrial development of the country, have to be maintained. The stress and strain of industrial life is greater now than ever it was before. These are various factors, particular to different concerns, which have an effect on the working capacity and the health of the worker. Cooling properties of the atmosphere (not the temperature of the air), which include conditions of humidity and ventilation, noise, physical stress and fatigue, various fumes and dust, and last but not the least, the nutritional condition of the individual, have an important modifying influence on production. To get the optimum result, the effects of these disturbing conditions have to be studied and methods evolved to counteract them. Labourers should be kept physically fit, under the prevailing working conditions, not only for helping to increase production, but also as an aid to preventing accidents. It is a known fact that even highly trained workers become involved in accidents, when they lose their mental and physical alertness through fatigue and over-work.

The subject of Industrial Physiology should occupy a prominent place in the plans of industrial development of the country. When large sums are being spent on wages and amenities and the cost of production is rising, the efficiency of the human factor should be increased to increase the amount produced. It should be the special interest of the industrialists to help the Physiology Departments in instituting special study and research in Industrial Physiology.

Nutrition and Metabolism.

The conditions imposed upon man by modern civilisation, have stimulated the study of nutrition and metabolism. Distances are no longer bar to travel and transit, and the food habits of the people are no longer restricted by purely local conditions. The supply of food materials, in the present economic set-up, has become a world problem. This is becoming acute, and the present geographical distribution of the world population make it plain, that without substantial readjustment of the means of subsistence from the place where it is produced to the place where they are used, something over half of all human beings could not go on living at all. City dwellers must be provided with all they need, all they eat, all they wear, even their very homes. They have got to secure their nutritional requirements from the available food materials.

Moreover, as a result of war experience in the West, nutrition is slowly emerging as a branch of science, in which a large amount of research is needed. The entire population of the war affected countries, like Poland, Jugoslavia, France, Belgium, Austria, were living precariously on practically starvation diet. In these places and in other countries, with wartime rationing, like England, large groups of people have involuntarily been subjects of big scale experiments. The observations have often been surprising and have led to considerable readjustments of our ideas about nutrition and deficiency diseases. Experiences gained in the rigorous testing conditions imposed in war, have cast doubts on the results of laboratory procedures and a tendency to be guided by human experience has increased.

In India people are living practically under post-war conditions, acutely aggravated by the sudden uprooting of a large volume of the population from their normal environment. It will take some time for the refugees to settle down and get acclimatised but it is their growing children who are likely to suffer most.

There is urgency in the solution of the nutritional problems confronting people in every sphere of life, all over India. It will be the duty of the physiologists and the nutritionists to devise a physiologically suitable diet from the available materials. This will be possible when the metabolism and the nutritional requirements of the people and the biological food values of the available materials are known.

The solution of this problem will require careful planning and concerted team work by Indian scientists. Side by side with the laboratory experiments, attempts should be made to throw further light on these results by conducting dietary surveys and determining the nutritional requirements and status and the deficiency diseases in man. This should also include the study of the nutritional requirements of the domesticated animals, which are rich sources of valuable food materials.

Many institutions in India have already started intensive researches in nutrition and diet. Biochemists and nutritionists of repute with teams of efficient workers are collecting valuable data. But this vast country with its diverse population will require a much larger number of institutions and an army of trained physiologists and biochemists for the successful solution of this very big problem.

I am afraid, I have taken up a considerable portion of your valuable time and taxed your patience in trying to indicate a few important directions in which the special study of and researches in Physiology may be profitably undertaken for the benefit of the people of this country. Every one of you, I am sure, will be able to make substantial additions to this list.

The health and efficiency of the people, under all conditions of stress and strain, has not only to be maintained but the standard raised. Human activity and productivity depend on factors, which are something more than just sound health. Our scientists have to solve the problem of increasing our capacity for work, both physical and mental, while engaged in different spheres of activity. These often require adjustments and adaptations based on physiological principles. We must live, we must advance and it is the improvement in the human factor, which should get first priority in our national planning. Our popular Government is already trying to do that, but where are the men—the specially trained men—who will help the Government to successfully solve these diverse problems in Physiology?

India will need a large number of well trained physiologists to tackle her innumerable problems and the Departments of Physiology in this country will be required to supply these workers. This is only possible, as I have tried to indicate, by treating Physiology as an independent science subject of great importance and the universities instituting advanced Post-Graduate studies and researches in all its branches. The Post-Graduate Physiology Departments should be properly equipped with the latest types of high precision apparatus and appliances for specialised studies. Aviation Physiology, for example, will require specially fitted up laboratories with elaborate physiological and areonautical apparatus. If necessary, we should secure the help of specialists from abroad to organise research in some of the highly technical branches.

I appeal to you all, to the physiologists who are present here today, and also to those amongst us who have not been able to attend, to make a serious and determined effort to elevate the science of Physiology to its deserved status. Let us put our heads together to prepare carefully plans for inaugurating and stimulating higher studies and extensive researches in Physiology.

I appeal to our brother scientists in other branches, to our national leaders, to extend their helping hand to us. I appeal to our people's Government, to our universities and to the learned scientific bodies to give their serious attention to this essential matter and grant substantial aid to develop this much neglected, yet vitally important, science.

SECTION OF PSYCHOLOGY AND EDUCATIONAL SCIENCE

President: Principal T. K. N. Menon, Baroda Training College.

Presidential Address.

TEACHERS AND EDUCATIONAL *RECONSTRUCTION*:

I am very grateful for the honour which the Indian Science Congress has conferred on me by electing me to preside at the Psychology and Educational Science Section of this session of the Congress. Please accept my sincere thanks for giving me this great honour.

I hope to place before you some facts and thoughts concerning a very important problem in educational reconstruction in India, *viz.* teachers. The spread of education in our country cannot be achieved and our target of *universal compulsory primary education for all* and an adequate provision of secondary education for those who have the mental capacity to profit by it cannot be reached unless we solve the vexing problem of providing an army of proper teachers. The importance of the problem is the chief reason for its choice for this address. If there is another reason for the choice of the subject, it lies in the fact that I have been associated with the selection and training of teachers during all these years and some members of my staff and myself have been studying recently the problem of teachers in India.

THE TEACHERS WE NEED

Five years ago when we met at Delhi, an illustrious president of our section, Dr. John Sargent (now Sir John Sargent) discussed in his presidential address the practical aspect of educational reconstruction. Sir John Sargent argued that if primary education were to be universal and compulsory, and if secondary education were to be provided to 20-25% of the eleven-twelve age groups, we need more than 22,00,000 additional teachers. Sir John believed that they should be recruited and trained, and he gave us a plan for achieving this in the course of forty long years. This happened in 1944. India since then has gone through a silent revolution. We won our freedom, but the country had to face an unfortunate partition. We are today concerned only with that portion of India which is ours *i.e.*, the Indian Union. But the magnitude of the problem of teachers is the same today as it was when Sir John spoke at Delhi and this will be evident from the following: The population of the Indian Union according to 1941 census figures is 315 millions and assessing it according to the rate of increase of population usual in our country, it will be 360 millions in 1951. The education of the children of this population will require approximately 14,40,000 teachers for our Junior Basic Schools, 5,74,000 teachers for the Senior Basic Stage and 2,64,000 for high schools, thus making a total of 22,78,000 teachers. In arriving at this figure I have assumed (1) that we shall have compulsory education for all between 6 and 14, (2) that 20% of the mentally gifted children will be provided with secondary education,

(3) our classes will have strengths of 40 and (4) an allowance of 25% of the numbers should be made in the assessment because our classes in all our schools will not have for obvious reasons that ideal mathematical quantity of 40 children that we would like them to have. In other words the requirements of educational expansion and, indeed, the country's self-respect demand that we should provide in the shortest possible time and with the maximum efficiency that we could afford this collosal army of about 2.3 million teachers.

CONSCRIPTION OF TEACHERS.

Sir John Sargent, who like his other countrymen was imbued with a conservative sagacity told us that this army should be raised cautiously and could be done only in the course of forty years. Forty years is an intolerably long period for the realisation of a social reform which not only our self-respect, but also the immediate needs of the country cannot accept. Besides, after the realisation of our Independence we cannot be content with programmes which were considered adequate for the old regime. There can be no argument against the contention that it is the birthright of every individual to receive at least the basic education without which he cannot fully discharge his duties as a citizen of a free country. The secondary school is the backbone of a national educational system, for it is to the high school that the country must look for the training of its leaders and experts in all walks of life. Provision of an adequate number of secondary schools is also therefore an indispensable need. It was for the above reasons that some time back India's Education Member, Hon. Abul Kalam Azad suggested some kind of conscription to raise the required army of teachers. If every matriculate is required to put in one year's and every graduate two years' service in education before he or she obtains his or her certificate, we could get a large supply of teachers for the purpose and thus could solve the problem of teachers in about five years. This is an opinion voiced by a large number of people in our country who are fired by a revolutionary idealism as against the conservative sagacity of Sir John Sargent and his school of thought.

ISSUES INVOLVED IN CONSCRIPTION

My purpose today is to spotlight the teacher, the good, the tolerable, and the bad ones and show how far it is possible to have an army of at least tolerably good teachers to speed up the educational expansion. I do not for a moment suggest that India can tolerate the delay of forty years to accomplish an educational expansion that is an imperative necessity incumbent on us. We cannot afford the extravagance of such a delay. But certain questions and issues arise and one cannot but face them and find answers and solutions to the same. Do the demands of urgency and speed justify the conscription of teachers? Does the idea of conscription find support from educational theory and practice? How has the idea of a teacher evolved during the ages and what have the East and the West to say about the evolution of the concept of a teacher? What are the ingredients of teaching ability? What have modern researches on the question to say about this and its consequent application, the selection of teachers? Are the qualities that go to make teaching ability to be found in all or only in some persons? If we are able to answer the above questions, and answer problem of technique, it is said, arises when resources are to serve one single end, the problem of economy when both ends and means are multiple. Since it happens ends *are* numberous and since, therefore, the problem of economy is ubiquitous in our society, your technique and your design will lack perfection unless they are consistent with maximum economy. The engineer, if he is to be a true servant of the society, will have to combine the technical with the economic. In a world in which the majority of inhabitants are still very poor, this consideration,—the adjustment of technique to economy,—turns out to be of supreme importance.

Nowhere perhaps is this problem of economy more acute and the role of the engineer in raising the standard of technique more urgent than in our own country. India's poverty is a by-word. The standard of living of the country is amazingly low. The majority of the people live on the starvation level. You move with eyes open and you see poverty writ large on the face of the country. Our basic preoccupation—now that we have power to shape things in our own way—must be to eradicate this economic evil. This is our supreme problem and all other problems—whatever their immediate significance may be—are subservient to it. One often hears of mal-distribution of income, of concentration of wealth, of exploitation of labour and so on. These have their places; but they appear to be mere jargons in the context of an economy where even complete equalisation would leave a man with an income far less than what is necessary for just physical existence. It has been recently estimated that the barest minimum requirement of an individual in our country is Rs. 74|- per year at pre-war prices, whereas, according to the latest calculation, the actual income per head is no more than 65|- per year. Here I feel tempted to give you the results of an investigation recently done by the great statistician, Colin Clark of Australia, which would indicate to you the over-all economic position of India *vis-a-vis* the rest of the civilised world. To eliminate local peculiarities in respect of conditions of work etc., Colin Clark measures the real income of different countries by way of the quantity of goods and services obtained per man-hour of work done; and he then translates the goods and services in terms of a common standard of value,—the international unit, as he calls it. A comparison of man-hour productivity in international units then provides an idea of the relative economic position of the different countries. Here are his figures for the pre-war year.

Countries	Man-hour productivity in International units.
U. S. A.	1
New Zealand	0.87
Canada	0.75
Australia	0.59
U. K.	0.56
Germany	0.49
Holland	0.45
Sweden	0.40
France	0.40
Italy	0.21
Japan	0.19
Russia	0.18
India	0.07
China	0.03

them we must, we shall be in a position to see how quickly we can raise our army of teachers.

TEACHER DOWN THE AGES.

Let us first have a peep into the history of education before we set about to examine modern researches done by experts and which as I said before we have tried to follow up in Baroda. What have our educational thinkers down the ages and educational systems from their naive beginnings of ancient times to their highly developed forms of today to say about the professional and personal qualities of the teacher? What were the demands made on teachers by the galaxy of educational thinkers and philosophers beginning with Plato and coming right up to our times of Dewey and Gandhiji? What did the educational systems expect of teachers from the times of ancient Greece and the Vedic period to the modern times of the Activity School, the Wardha school, the Dalton Plan and the Project Method? Did the humanitarian motive in education of the nineteenth century and the psychological, sociological and scientific tendencies specify certain minimum requirements or allow all and sundry to take to the teaching profession? Does the broad canvas presented by history, of education, a canvas on which is depicted education endeavours with their trials and errors, successes and failures, that canvas the sure guide for our educational adventure provide the examples for us to follow in the matter of raising our army of teachers, a requirement that is immediate and indispensable?

From the dawn of history each social group has passed on its accumulation of beliefs, practices and institutions to its children who in turn passed on this heritage to their offspring. At first the process was simple, but changing social, political and industrial conditions led to more specialised activities and more complicated forms of social co-operation. The result of all these changes, which consumed centuries of time, was that parents came to have little time to devote to their children; furthermore their lack of adequate training made them unfit to guide their children in a more complex environment. The final outcome was the establishment of schools and the selection of specially trained individuals as teachers. In certain periods of history only a chosen few were selected to be educated. In some cases the child was educated only for the State; in others, for and by a religious institution. Then appeared the humanitarian motive and the sociological tendency in education which demanded education for all. There thus appears to have been two points of view before educational thinkers with regard to professional requirements. The teacher, according to one view, is an agent of the sovereign State. From it he receives his compensation, and to it he is accountable. From another view point, the teacher is a minister to all humanity. Walter Lipmann in his convocation address to the University of the State of New York has brought into bold relief the contrast between the two points of view. He says "the place of the teacher in public life............cannot be truly conceived unless we are clear about the relation between the teacher who is a minister of the tradition of higher learning on the one hand, and governments, parties, and the various contending interests in a society, on the other. There are two views of this relationship and they are everlastingly in conflict with each other. In the one view, the teacher is a minister of the sovereign. In the other view, the teacher is the minister of the universal conscience, enlightened by learning, which guides the sovereign and judges him. In the one view, the teacher takes an oath to follow the king, the dictator, the magnates, the majority, the mob, to follow and serve the purpose of those who exercise supreme power in a society. In the other view, the teacher takes an oath to advance learning and perpetuate it to prosperity in order that there may be standards that inform, control and criticise the actions of the sovereign, of kings, dictators, magnates, majorities or mobs. In the one view, the teacher is a custodian of a tradition which is higher than any ruler, and learning is not the instrument, but the criterion of the ruler's power.'"[1]

EDUCATIONAL THINKERS AND THE TEACHER.

Whichever view we take, we cannot escape the implication that the teacher's is not a job meant for all, but only of a specialist and a selected few. Let us examine these views as formulated by educational thinkers and philosophers. Plato, the earliest among those whose contribution to education is by no means insignificant asks a very pertinent question. "Shall we,............lightly suffer our children to listen to any *chance teachers* and so to take into their minds opinions for the most part contrary to those that we shall think it desirable for them to hold when they are grown up?"[2] Plato himself answers the question by saying that "we must begin by a censorship over our own story-makers"[3] and by this censorship he means nothing but the selection of teachers. In selecting teachers Plato would look for "those craftsmen who by the happy gift of nature are capable of following the trail of true beauty and grace, that our young men, may receive benefit from all things about them."[4] Aristotle, Plato's pupil's whose aim of education was the attainment of the good, wanted as teachers only those who could achieve this lofty and sublime aim. Those who practice virtues, who are proficient in the subject, are competent and trained could pass the test of Aristotle. Plutarch argues in a similar vein. How aptly he has quoted the proverb to emphasise the qualities of the teacher! "If you dwell with a lame man, you will learn to limp";[5] therefore he advises his countrymen, "Teachers must be sought for the children who are free from scandal in their lives, who are unimpeachable in their manners, and in experience the very best that may be found."[6] Quintillian who forms the educational link between the era before and after Christ would not leave teaching to chance. "We must," says Quintillian "spare no effort to secure that the purity of teachers' character should preserve those of tender years from corruption, while its authority should keep the bolder spirits from breaking out into license."[7] A knowledge of child psychology seems to be another necessity that he demanded of the teacher because he remarks, "It is generally and not unreasonably regarded as the sign of a good teacher that he should be able to differentiate between the abilities of his respective pupils and to know their natural bent."[8]

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1. The Place of Teacher in Public Life: Covocation Address of the University of the State of New York: 15-10-1936.
2. The Republic, Book II: Plato.
3. Ibid.
4. Ibid.
5. Lives: Plutarch.
6. Iibid.
7. de Institutione Oratoria: Quintillian.
8. Ibid.

The Christian Era brought with it education for and by the church. Writing about the clergy who are to teach, St. Basil of the third century says "Let a monk of some age be put in charge of children, surpassing the rest in experience and with a reputation for patience, able to correct the sins of youth with fatherly compassion and skilled words." We have the authority of Gerson to show that medieval church looked upon teaching as "the skill of skills." "It is best," says Gerson, "to forego all false dignity and to become a child among children............he will not be able to convince them unless he smiles kindly at the laughing ones, encourages those who play, praises their progress in learning and when remonstrating avoids all that is bitter and insulting."[1] With the Renaissance, teaching profession gained in importance and the teacher's was looked upon more and more as the job of a specialist. According to Martin Luthar, if a nation was to be elevated, it should have efficient teachers. 'To be brief' says Luthar, "an industrious, pious schoolmaster or teacher who faithfully trains or educates boys, can never be sufficiently recompensed, and no money will pay him............Yet this calling is shamefully despised among us, as if it were nothing."[2] Luthar's reproaches meant for the people of his times are appropriate for the people of today. The Jesuits who voiced the Catholic faith organised the work of teaching to a method and the duties of a teacher to a code. Comenius and Locke, the two veteran educational thinkers of the seventeenth century have also wise counsel to give on the question of the teacher. The former wants as teachers only those who have an understanding of the psychology of the human nature as a basis for interconnecting the methods of education with the laws of mental growth. The latter who is concerned with the training of a young gentleman, wants a tutor to be selected for the purpose. The tutor "in the first place should be well bred,............besides being well-bred, the tutor should know the world well; the ways, the humours, the follies, the cheats, the faults of the age he is fallen into and particularly the country he lives in."[3]

We might say that with Rousseau in the eighteenth century starts modern education. Scintillating with wit, glowing with passion his writings throw a cometary splendour in their criticism of the education of his time. Rousseau's "Education according to Nature," and even his "Negative Education" which "aims at guarding the heart against vice and the mind against error"[4] admitted of a carefully selected teacher. The psychological, the sociological and the scientific tendencies in education that he originated prescribe definite qualifications and attainments of the teacher, *viz.*, a knowledge of the child mind, love for children and love for nature. In the nineteenth century Pestalozzi, the greatest teacher of all times brought Rousseau's teachings to the classroom and made them concrete in the hands of every teacher. He reformed the spirit of the classroom by driving away the cobbler school master of his times and by replacing him by the trained teacher. He gave the world the idea of training of teachers and worked out methods of instruction. With Pestalozzi started the modern selection and training of teachers. Two of his disciples whom Pestalozzi trained were Herbart and Froebel. The three are the outstanding stars that shine in the educational

1. Treatise on Leading Children to Christ: Gerson.
2. Duty of Sending Children to School: Lutur.

firmament of the nineteenth century. Herbart gave us the first educational psychology and insisted that every teacher should learn it before entering the teaching profession. Froebel conceived the beautiful idea of the kindergarten—a school for infants which should be a garden where the plants and flowers are children. The teacher's role is that of the carefully selected and trained gardener who should make the best advantage of the activity of the child and facilitate the natural, progressive and harmonious development of all his powers.

If the exponents of the psychological tendency in education emphasised that only those who had an inherent love and liking for children should be selected as teachers and then they should be trained in child psychology, the advocates of the scientific tendency in the nineteenth century inisted that a knowledge of the important subjects, particularly the sciences should be a pre-requisite to taking to teaching. Herbert Spencer and Thomas Huxley, the exponents of the scientific movement said that what should be taught in schools is "the knowledge of most worth." This knowledge inevitably begins with the sciences and only those who have a knowledge of the sciences and ability to teach the sciences should be tolerated as teachers. In this century educational theory and practice have been influenced by Madame Montessori and John Dewey. Madame Montessori who is concerned essentially with the education of infants takes her inspiration from Froebel and holds views on teachers similar to those held by the author of the kindergarten. Thanks to her presence in India, we are now used to her ideas about teachers and their training which she herself has been conducting. Dewey takes it for granted that teachers will be selected and trained. His writings stress that education should adjust itself to life which has been revolutionised by modern industry. Education has failed to keep pace with the rapid changes in life brought about by industry and teachers should be selected and trained for Schools of Today rather than those of Yesterday.

THE TEACHER IN ANCIENT INDIA

When we turn our attention to our own country we find that the Indian teacher is the inheritor of a great and proud tradition. Right from the beginning of our civilisation the teacher has been occupying an eminent position in our society because of the importance of the duties to which he dedicated his whole life. He was the custodian of all knowledge which he got as a National Cultural Legacy from his Gurus and it was incumbent upon him to keep on adding to it. Imparting the knowledge to the next generation was the paramount duty of the teacher and those who failed to perform this either through indolence or deliberate neglect became the targets of universal contempt. Teachers in Ancient India believed that the debt due to the Rishis could only be discharged by mastering and transmitting to the next generation the accumulated knowledge possessed by the race. The teacher as the agent of this transmission and one endowed with a unique capacity of doing independent high level thinking naturally occupied a pre-eminent position as the trustee of the National Culture.

In order that the teacher may always keep abreast of all educational developments, it was enjoined that he should ever remain dynamic. Constant progress, life-long study and ceaseless struggle for widening the frontiers of knowledge by exploring newer spheres were expected of him. Those who wanted to barter knowledge for money were ruthlessly condemned. An overwhelming majority of these teachers were householders; also later and more particularly in Buddhistic days, monks and Sanyasies undertook to educate the people.

The teacher in Ancient India had to lead a life of rigorous self-discipline, self-denial and constant literary and cultural activities. Whatever he talked he had to act upto; his life was exemplary from both the educational and moral view point. Because wealth was considered a hindrance to learning, the teacher in Ancient India always insisted on voluntary poverty. He stood uppermost in knowledge, morality and self-sacrifice, and was admired and respected by all. Nor did our ancient seers miss the importance of moral character in its relation to knowledge. Knowledge had its own place as the parent of civilisation, but character was correctly considered the very core of social work. Those who were slaves to unbridled passion and led immoral lives stood condemned in spite of all the knowledge that they possessed.

Profound knowledge and deep scholarship, sterling virtues and ideal character, a spirit of sacrifice to effect social reform—these are the pedagogic traditions that Ancient India has passed on to us. If only we had preserved this unique legacy and worked on it and enriched it just as its authors did in ancient times, we would not have been in the miserable mess of ignorance and illiteracy in which we find ourselves today. Foreign invasions and alien rules did not allow our ancient institutions to a continuity of existence and our ancient pedagogy to pursue its progress. Relics of our ancient institutions and descendents of our ancient Gurus are yet to be seen in some parts of India. The fact that they have survived the vicissitudes of centuries, of defeat and disappointment speaks volumes of their intrinsic worth.

MODERN RESEARCHES ON TEACHING ABILITY

Rich indeed is the background of knowledge about teachers furnished by educational thinkers and educational systems from ancient times down to the dawn of this century. It is no wonder that with such a rich background of knowledge, the modern experimental psychologist found here a fertile field for his labours. During the last two decades he has been busy trying scientifically to fix the qualities that make up teaching ability and to measure teaching efficiency. We have been at this task in Baroda also, but before indicating our results, let me take you quickly through the large amount of work done by reputed workers which as in other branches of modern educational science has been in the West.

The researches relating to qualities essential to success in teaching have been made from the following five angles:

(a) causes of teacher failure, (b) compilations of the opion of pupils, (c) compilations of expert opinions, (d) studies of good and bad teachers and (e) correlation studies of factors related to teaching success.

TEACHER FAILURE:

A summary of the investigations presented by A. S. Barr list the causes for the failure of teachers which are the *lack of the following*:

(1) Control over the tecnique of teaching, (2) ability to maintain order and discipline, (3) mastery of subject matter, (4) in-

> telligence, (5) effort, (6) initiative, (7) adaptability, (8) common sense, (9) physical ability, (10) standards of teaching efficiency, (11) ability to carry on, (12) singleness of purpose, (13) sympathetic understanding of the pupil, (14) social background, (15) knowledge of what pupils can do, (16) personality and (17) moral standards.[1]

Opinion of Pupils:

Among the studies the two important ones have been made by Davis and Hart who collected the opinions of about 22,000 and 10,,000 pupils respectively. Among the qualities of a good teacher that secured high frequency of mention were fairness, kindness and sympathy, skill in teaching, good nature, good discipline, knowledge of subject, sense of humour, good personality, strong character and interest in pupils.[2]

Expect Opinion:

There have been a number of studies which aimed at collecting the opinion of heads of schools and other persons who are considered competent to assess traits having a significant relation to teaching success. The most important traits listed in these studies are discipline, teaching skill, intelligence, physical health, personality, resourcefulness, scholarship, preparation, fairness and co-operation. Charters and Waples followed a systematic procedure and derived a list of 25 traits considered important in training and judging teachers. Barr and Evans made an analysis of 209 rating scales to discover the qualities most frequently expected of good teachers. There is substantial agreement between Charters-Waples ranks and Barr-Evans ranks and all the qualities referred to above find a place in both the lists.[3]

Good and poor Teachers:

Trere have been many studies. Barr's intensive study of 47 good and 47 poor teachers is typical. He summarises thus the distinguishing characteristics of each type: "A good teacher motivates her work. She asks many thought questions and employs a good technique in the process. She conducts class discussions in a conversational manner, makes frequent use of pupil's experiences and attends carefully to pupil responses. She possessess a wealth of commentary expressions and employs some system of appraisal other than teacher appraisal. She socializes class discussions, makes frequent use of illustrative materials and provides definite directions of study. She follows a topical organization and assignment of subject matter, makes some provision for individual differences and shows superior knowledge of subject matter. She requires note-books and outside reading, has a well established procedure for examinations and good discipline. She is pleasant and smiles appreciatively and laughs with the class from time to time. She is enthusiastic, patient and possesses a good sense of humour. She stands throughout the greater part of the class period.

"The typically poor teacher has poor discipline, is incapable of stimulating interest and makes no provision for individual differences.

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1. Teaching Efficiency: A. S. Barr: Encyclopedia of Education Research.
2. Ibid.
3. Teaching Efficiency: A. S. Barr: Encyclopedia of Educational Research.

She follows a textbook assignment and organisation of subject matter, provides formal textbook teaching and makes little effort to socialize class discussions. The poor teacher appraises the pupil's responses but possesses few commentarial remarks for this purpose. She may be lazy, she may loaf or she may bluff; she may nag her pupils, show favouritism, or be too familiar with the boys in her class. Some poor teachers are sarcastic, some dictatorial and some indifferent. The list of weaknesses shown by poor teachers is a long one."[1]

CORRELATION STUDIES:

These studies seek to identify qualities essential to teaching success by calculating the correlation between measures of teaching success. The results indicate that teaching success has no correlation with age and experience, but has high correlation with personality traits.

An overall examination of all these researches and results lead us to the conclusion that successful teaching depends on seven factors. They are:—

1. the teacher's personal equipment,
2. his professional equipment,
3. his cultural background and academic equipment,
4. his physical equipment,
5. his mental equipment,
6. his emotional stability and
7. his social adjustment.

The traits or qualities involved in each of these factors will be evident from the following table:

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[1] Teaching Efficiency: A. S. Barr.

SUCCESSFUL TEACHER

Personal Equipment	Professional Equipment	Cultural Background and Academic Equipment	Physical Equipment	Mental Equipment	Emotional Stability	Social Adjustment
Personal appearance; refinement; pleasant manners; industry; enthusiasm; drive; initiative; open mindedness.	Knowledge of psychology, of aims, contents, methods, materials of instruction; skill in teaching, interest in teaching etc.	Knowledge of subjects taught and general information, cultural background etc.	Health physical energy, vitality, freedom from physical defects and contageous diseases etc.	Intelligence, mental alertness, judgment, common sense.	Self-control, mental balance, tolerance, freedom from unreasonable beliefs, prejudices etc.	Knowledge of social conventions, ability to get on with others, good moral conduct etc.

BARODA INVESTIGATIONS.

The Baroda investigations took into consideration the above results. These investigations were aimed at finding out (1) the pupils' opinion of good and bad teachers (2) the expert opinion regarding the same and (3) what degree of agreement there is between the two opinions. Four different approaches were made to collect pupil opinion. They were (a) the Essay Method, (b) The Interview Method (c) the Ranking Method and (d) the Concrete Question Method.

The Essay Method:

243 children of Standards VI and VII of high schools were asked to write an essay on "What I would like my teacher to be". This method is particularly suitable for research in schools for different reanson, the possibility offered for the collection of a great quantity of material in a short time, the avoiding of prejudicing children by narrowing the question basis as happens with questionnaires, using a method to which children are accustomed etc. In order to avoid the danger that the fact of the pupils being in schools might prejudice their views, the children were given freedom to write it at home, or school and in some cases without signature. The ages of the group varied from 14 to 19. The majority of them were between 15 and 18. The results of those not belonging to the above age range were discarded and there were 210 cases for study. The characteristics mentioned were listed and their emphasis noted in terms of rank. An analysis of the results showed that pupils stressed the following qualities more or less in the order of preference: Friendly attitude, good teaching, impartiality in class and examination, good discipline, jolly and humorous. The children appeared to be least interested in good appearance and smart dress.

The Interview Method:

For the purpose of this method, we chose children of the same age group as mentioned above. A little over hundred children were interviewed by a panel of lecturers of the Training College who fixed the technique of interview beforehand after discussion. The children were made to feel homely and they were questioned about their ideas of good and bad teachers. The children attacked the problem with considerable enthusiasm after they were assured that their talks will be treated as confidential and would not in any way influence an estimate of their studies. The traits they mentioned were noted and before each pupil was allowed to go, a summary of the qualities mentioned by him was presented to him and he was asked to rank them in the order of their importance. The following qualities are in the order of the frequencies in which they were given:

Good Teachers: should teach well; should be a good disciplinarian; should be friendly; should be impartial; should not be excitable and insulting; should be learned and should have plenty of general information.

Bad Teacher: shirks work; irritable and rude; partial to favourites; gets private work done by pupils; bad disciplinarian and is shallow in general knowledge.

THE RANKING METHOD:

This method arose out of the two previous methods. A note was made of the traits and qualities of good and bad teachers as found in the results of the previous studies and as commonly observed by the college staff in both the types that they came across in the course of their work. Nine of the most important reasons for a teacher being liked best and an equal number of important causes for a teacher being liked least were presented in the form of a ballot paper and children were asked to rank the reasons in the order of their importance. The opinions from about 3000 children of the same age group as mentioned above were collected. The children belonged to schools in three important centres in Gujarat—Baroda, Surat and Ahmedabad. The results were analysed and the frequencies of each reason under preference first, second, ... nineth were found out. A remarkable relation was noticed in the results. Those reasons which secured highest first preference secured also high second and third preference and very low seventh, eighth and nineth preferences. The traits that secured very low first, second and third preferences secured very high seventh, eighth and nineth preferences. This showed that pupils were clear and definite about their views of good and bad teachers. They rated good teaching as the first trait of a good teacher, and bad teaching as the first trait of a poor teacher. Among the other traits that got high ranks in the case of a good teacher were friendly and brotherly attitude, impartiality in class and examinations and a jolly and humorous nature. The corresponding items in a bad teacher were the teachers' insulting and rude nature, excitability, partiality and lack of understanding of children's difficulties.

CONCRETE QUESTION METHOD:

According to this method the pupil was asked to bear in mind the best teacher he had in his school or schools, and then state whether the teacher in question had certain qualities and traits. About forty questions put to the child covered all the important traits. These traits when grouped under seven headings—personal equipment, physical equipment, professional equipment, mental equipment, culture and academic equipment, emotional stability and social adjustment—showed that all the teachers whom pupils preferred had professional equipment, emotional stability, mental equipment, social asjustment and to a certain extent personal equipment.

The results of the four separate investigations prove clearly that pupils' opinions about the teachers are clear and definite. We cannot ignore this opinion just because it comes from pupils. The proof of the pudding is in its eating and so long as children are consumers of teaching, their opinion should be given its proper weightage. After all without the learners' active co-operation, attempts to make him learn can produce only meagre results. The adolescents are noted for their open-heartendness and love for truth, and there is no reason therefore to believe that the opinions of teachers collected from hundreds of adolescents were given without a sense of honesty or with any mental reservation. Now it remains for us to see how far pupils' opinions agree with the so-called expert opinion—the opinion of those who employ and supervise the work of teachers. When we go to a restaurant, we judge the food we eat. We do not accept the verdict of the one who prepares it unless he be a hypnotist! Therefore children's opinion of teachers is more useful than those of persons who teach or prepare teachers or supervise the work of teachers. We shall, however, have a look at the opinion of these producers of teaching.

The opinion of headmasters, school inspectors, training college staff etc. were collected by means of a questionnaire. They were asked to rank a set of qualities that are generally considered as those contributing towards teaching success or teaching failure. Only ten important qualities and traits under each head were presented and the experts were allowed to add two more if they felt that the important qualities were not included. The opinion collected revealed that the experts put emphasis on the following traits in the case of good teachers: (a) good discipline and class control (b) good teaching and getting work done by pupils. (c) obedience and loyalty, (d) co-operation in all forms of school work and (e) good character and manners. According to the same experts, those qualities that were chief contributory factors to failure of teachers were: (a) do not teach well, (b) quarrelsime in school and examnation discipline and class control, (d) dishonesty in school and examination work, (e) no interest in school work, curricular and extra curricular. It is but natural that experts should consider that poor teaching is a result of the teacher not possessing the traits that contribute to success in teaching or by his possessing the opposite qualities. The collection of more expert opinion by other methods and also the opinion of others are in good progress. The data available now show that experts and pupils agree on all vital matters regarding good and bad teachers.

GANDHIJI ON THE TEACHER.

During the last two or three decades, India has been used to look to the advice of Gandhiji, the Father of Our Nation, whenever it was confronted with a crisis of with any other difficult problem. It has followed the advice given by the Mahatma and has always profited by it. Why should we not follow then his advice regarding the teacher, particularly when we are putting an emphasis on the Scheme of Basic Education of which he is the author? Gandhiji's views of the teacher are as clear as they are definite and they were formulated as early as in 1931 and given out to the British public in an interview which the Teachers' World had with him. He said that the Gospel of Love should be the cardinal principal of the education of children. Character to Mahatma was more important than anything else and the development of a child's character should take procedure over his acquiring knowledge and storing of facts. Since character building is to be the positive factor in education, Gandhiji wanted above all teachers of strong character. Gandhiji would not have the "commonplace teacher"; he wanted as teachers only those who could draw forth the best that is in the child through understanding, sympathy and appreciation. All have not got the virtues stressed by Gandhiji nor indeed the knowledge of children and ability to establish ideal relations with them through the medium of love and understanding. It needs careful selection of well adjusted persons and their training to satisfy Gandhiji's idea of a teacher worth his name.

SELECTIVE CONSCRIPTION AND EMERGENCY TRAINING

My quick survey of the idea of the teacher from Plato to Dewey and from the times of the ancient Greece and the Vedas to the twentieth century make it clear that at all periods in the history of the human race, the teacher has been considered as a specialist. At all times, there was some kind of selection and some kind of training. My rapid review of the twentieth century experiments at fixing the qualities and traits that go to make teaching ability has only confirmed the views of our educational philosophers. Our twentieth century experimental psychologists have given a scientific basis to what our educational philosophers stated in general terms. The little work that we are doing in Baroda only confirms the view of the western investigators and shows that the problem of the Indian teacher in spite of its particular difficulties present all the general problems that teachers of any country ever did. Gandhiji, the Father of Our Nation will not have the "commonplace teacher"—he wants teachers of character, teachers carefully selected and trained.

In our attempts to raise the army of 2.3 million teachers, can we afford to miss all the qualities that educational thinkers, educational systems and educational experiments have demanded of the teacher? Are we going to ignore also the advice that Gandhiji himself has given in this respect, Should we not insist on at least certain indispensable requisites in our tteachers even if we venture to overlook a number of desirable traits and qualities? After recruitment, is the candidate to be sent directly to teach in the school? Is he not to be given at least some kind of professional preparation? Conscription of teachers in the sense in which it is employed today allows no selection and provides no training. The idea of conscription originated with military service; even here, the deaf and the dumb, the cripple and his physically deformed associates are rejected. Those conscripted are given a thorough military training before they are allowed to go into action. Just as I write this, I read in the papers the strong criticism voiced in biting terms by a Member of the Bombay Legislature when it was discussing the conscription of teachers. The Member said that even a barber when he taught his trade to his son, made him try his razor first on the earthen pot! The child mind, I may add is more plastic and sensitive than the bearded chin and the ill-equipped teacher more dangerous than the barber's razor.

I hope that what I have said will leave you in no doubt that general conscription of matriculates and graduates to form our army of teachers is a dangerous proposition. We may use the word conscription if by it we mean compelling only the competent to serve as teachers. Then it will be wiser to use the term "selective conscription." This is not all. Those conscripted should be given some kind of training, some kind of preparation before they are asked to mould the destinies of the young ones of this country.

Our teachers even in an emergency need at least a mental equipment, an emotional stability, the necessary social adjustment and some kind of professional equipment. Expediency may allow the overlooking of personal and physical equipments and cultural backgrounds, but even these cannot be ignored after the emergency has been tided over. Approximately 50% of our matriculates and graduates will have to be rejected on the ground of their leacking the necessary emotional and social adjustments. If we do not do this selection in our conscription, but allow the emotionally unstable and socially maladjusted persons to enter the teaching profession even as stop-gaps, we should be prepared for the spread of the same kind of malady in the young ones of our land on whom we rest our hopes and aspirations. Thanks to the effort that this Section of Psychology and Educational Science has been making in recent years in impressing upon the authorities on the need for a Central Institute of Applied Psychology, such an Institute has now become a matter of immediate possibility. It should be possible for this Institute in co-operation with Training Colleges and other Institutes in the Provinces and States to formulate tests to facilitate selective conscription of teachers by weeding out the mentally crippled and disabled. One may concede, though only with some reservations, that our matriculates and graduates have the necessary mental equipment. Only psychological tests will enable us to find out whether they have also the necessary emotional and social adjustment. When once this selection is made, when the unfit are weeded out and the rest conscripted, the question of the professional preparation of our teachers remains. This is by no means unimportant. Viewed from the angle of professional requirements, our teachers already in service present by no means a satisfactory position. The latest available figures of teachers trained and untrained in the Indian Union given below show that under the existing circumstances, we do not have even two trained teachers to dilute the disadvantage of every untrained teacher in the country.

STATISTICS OF TEACHERS IN SCHOOLS FOR GENERAL EDUCATION IN INDIAN UNION (Less States) 1946-47.

Schools	MALES						FEMALES					
	Trained Teachers			Untrained Teachers			Trained Teachers			Untrained Teachers		
	Graduate	Non-graduate	Total	Graduate	Non-graduate	Total	Graduate	Non-graduate	Total	Graduate	Non-graduate	Total
Primary Schools	241	1,90,861	1,91,102	1,234	93,776	95,010	130	34,843	34,973	280	13,454	13,734
Middle Schools	1,082	24,875	25,957	1,267	17,274	18,541	339	4,857	5,196	456	2,472	2,928
High Schools	13,682	16,444	30,126	9,804	16,907	26,711	2,202	4219	6,421	1,148	1,758	2,906
Total	15,005	2,32,180	2,47,185	12,305	1,27,957	1,40,262	2,671	43,919	46,590	1,884	17,684	19,568

Note: As figures for 1946-47 are not available in respect of W. Bengal, E. Panjab and Delhi, those for the year 1945-46 have been included in this table.

The professional preparation of our teachers when once they are formed does not to my mind present the difficulties that have been generally raised. Sir John Sargent wanted 40 years for this preparation because he was thinking in terms of new training institutions to train this army in the traditional manner. For this army of teachers what is needed is a quick training for a period of emergency, a training lasting for 2 or 3 months when they will be given the fundamentals of knowledge of the child mind and the essence of the aim, contents, methods and materials of instruction. I feel that the potentialities of our existing training institutions and of the trained personnel available in the country have not been properly tapped. The existing training institutions can easily undertake to train at least three batches of emergency teachers in addition to those who will be receiving their usual full-time training. What is more important, they can organise many emergency training centres in selected high schools round about them. With the aid of the trained personnel available in these high schools and also of some peripatetic lecturers from the training institutions, the emergency training can be carried out with remarkable speed, efficiency and economy. What is needed today is not the working out of plans for new training institutions, but the finding out of potentialities of the existing institutions. My experience as the head of a Training College has convinced me that the existing training institutions, if given some more facilities and a modest increase of staff during the period of emergency will be able to train at least the major portion of the army of teachers we need with the help of selected high schools and the trained personnel available. It is unfortunate that a survey has not been made on these lines.

SUMMARY OF CONCLUSIONS.

I must now draw this discourse to a close. Though it means repitition, I take the liberty to sum up my views because the subject is of supreme importance to the country and I am sure you will bear with me, if only for the sake of our neglected teachers.

1. The minimum requirements of educational expansion in the Indian Union will require about 2.3 million additional teachers.
2. To raise this army of teachers, some kind of conscription is inevitable.
3. The idea of conscription has to be examined in the light of what educational thinkers and systems down the ages have advocated as the essential requirements of teachers and the modern researches conducted to fix the qualities and traits needed for success in teaching.
4. Educational thinkers and systems here and abroad have stressed the importance of certain qualities of which intelligence and knowledge, character and personality traits and professional skill are indispensable.
5. Modern researches have shown that to be successful a teacher should have personal, professional, physical and mental equipments and also a cultural background, emotional stability and social adjustment. The Baroda studies of the teacher also confirm this view.

6. Conscription of all matriculates and graduates as teachers in the sense in which the term conscription is generally employed is therefore a dangerous proposition.
7. Even for an emergency we should have only a "selective conscription" in which at least emotional stability and social adjustment should be stressed, it being granted that matriculates and graduates have the necessary mental equipment.
8. The proposed Central Institute of Applied Psychology in collaboration with the other Institutes and Training Colleges will be able to help this selection through tests to be formulated, and then Governments can conscript the selected candidates.
9. The candidates so recruited by "selective conscription" should be given an emergency training.
10. The existing training institutions with suitable additions and adjustments of staff and with the aid of selected high schools and trained personnel available in the country will be able to train at least the major portion of the army of teachers needed for educational expansion. A survey to find out the potentialities of the existing training institutions for this important work will be fruitful in the interest of speedy and economical educational expansion.

Let me thank you again sincerely for the honour you have given me. Will you not allow me also to remind you in conclusion that teaching in all countries and particularly in ours has always been a great vocation? Once we forget this simple fact, we should get ready to tread the downward path.

SECTION OF ENGINEERING AND METALLURGY

Presidential Address.

PRESIDENT: PROF. M. SEN GUPTA, B.Sc. (Cal.), B.Sc. (Eng.), Hons. Glass, M.I.E.E. (Lond.), M.I.E. (Ind.), C.P.E. (Glass), A.M.L., Mech.E. (Lond.), F.I.P.S.

FRIENDS,

I should first express my gratitude for the honour that you have given me by electing me to the Presidentship of your section. It is not merely a matter of personal pride to me, it is also a pride to the whole body of so-called academic engineers to which I happen to belong,—a body whose role in moulding the affairs of society has received so far rather tardy recognition at any rate in our country. The academic engineer is necessarily preoccupied more with 'principles', his world is limited to his laboratory and the workshop and he has none of the opportunities that a 'practical' engineer has of direct association with those great works which are supposed to be changing the pattern of our economy,—the great dams, the big canals and the like. His achievements are less exciting and less spectacular. It would not be unnatural therefore if he had been thrown into the background. Your choice of one like me to the Presidential Chair, however, gives the lie to any misgiving of that kind. It demonstrates your recognition that slow and imperceptible as their fruit may be, the services of your academic colleagues have potentiality and must be given their due place in the scheme of things. It underlines your acceptance of the necessity of a marriage between theory and practice.

While, however, I am gratified at this recognition of the class to which I belong, personally I feel weighed down with the heavy responsibility that my office carries. I know my limitations, and I know only too well that I am not worthy of the honour that you have bestowed on me. I am still a student of Engineering Science, just feeling my way towards it. It is not yet for me to offer you any new method and to guide you along any new path such as you would perhaps expect of your President to offer. I have no new tool to be added to the box of theoretical engineers, nor have I the experience of big constructive works to enlighten practical men.

Yet if, as somebody has put it, knowledge means 'conscious ignorance', I can perhaps claim to have that. I know a little of what I do not know and have a glimpse of what I ought to know. I can perhaps indicate to you the range and hence the limit of our science, the nature of problems that a practitioner in the science has got to face, the qualities that he must possess in order efficiently to discharge his task and the environment that must be there for a fuller functioning of these qualities. It is to these that I propose to address myself.

In the Charter (dated 1828) of the Institution of Civil Engineers (London) the aims and functions of Engineering have been defined as "the art of directing the great sources of power in nature for the use and convenience of man and subjects have been enumerated which are to come under the scope of Engineering, such as construction of roads, bridges, canals, ports etc.' Just a hundred and one score years have elapsed since this charter was made, and we have travelled far by way of extension and specialisation; we have now, besides civil engineering as such, branches like mechanical engineering, electrical engineering, chemical engineering and so on. And yet it appears the general view of what engineering stands for remains, at any rate in our country, much the same as is implied by this definition. Now, I have my misgivings about the significance of this way of looking at our subject. I have called Engineering a science. If you will, you might qualify it by saying it is an applied science. Surely you can no longer put it in the category of an 'art' without serious damage to its reputation and significance. It is all very well, so long as you adhere to the root meaning of the word 'engineer', as perhaps the early builders of the Institution of Engineers were prone to do, to have this narrow connotation and to emphasise the 'mechanical contrivance' aspect of Engineering. For 'to engineer', as your Oxford Dictionary will tell you, is 'to arrange'—'to contrive'. But the way the business of the engineer has developed all these years leave no doubt concerning its scientific implication. The great extensions in the range of Engineering that have taken place during the last hundred years have no doubt been the result of progress in the physical sciences yielding greater and wider command over nature; but they have at the same time opened the way to further research and investigation into the utilisational aspect of the fundamental discoveries of pure science. If the function of the pure scientist is to discover the causal nexus between phenomenon as they appear in nature, it is the function of the engineer to *invent* processes whereby the knowledge of this nexus can be utilised for the material benefit of mankind. The method is the same,—the scientific method of analysis and experimentation. In discussions on the purpose of science a distinction is often made between its 'light bearing' aspect and its 'fruit-bearing' aspect. It is doubtful whether the distinction is quite clear and precise, for, as I look at it, one merges into the other imperceptibly,—what bears 'light' do in the long run bear 'fruit', too. Yet I feel tempted to use these expressions to emphasise that your science is 'fruit bearing' *par excellence* and that it is here that its essential significance lies. You will perhaps use symbols, as the Mathematician does, as an aid to analysis; but your symbols must have positive content in the work-a-day world and your equations must have concrete counterpart in reality. How often have I noticed the *naive* glee of the student of Engineering Mathematics at his discovery of new relationships between mere symbols based on equations which are themselves purposeless. For a student of engineering this kind of excitement is dangerous. While, therefore, I would guard you against the traditional conception of Engineering as an 'art', I must at the same time urge you not to ignore its sociological import, the purposive character of all that you stand for. Your role is to be a link between the pure scientist and the mechanic. You need to possess the intellectual curiosity of the scientist. But you must also have the intuition and 'feel' of the practical man. For, whatever the method, the engineer's task is incomplete until he acquires competence in harnessing the powers of nature for 'the use and convenience of man'.

If this is so, the responsibility of the engineer is great and his path bristled with pitfalls. While he must know the theoretical implications of a body of forces, he must not rest until he is capable of adjusting the play of these forces to the environment and to the needs of the society. It will not do if he just shows the way to the building of a machine; he has to have a perception of the possibilities of its utilisation with reference to the resources and needs of the society. He has to be a bit of an economist, too. One often hears of the distinction between Technology and Economics. The problem of technique, it is said, arises when resources are to serve one single end, the problem of economy when both ends and means are multiple. Since it happens ends *are* numberous and since, therefore, the problem of economy is ubiquitous in our society, your technique and your design will lack perfection unless they are consistent with maximum economy. The engineer, if he is to be a true servant of the society, will have to combine the technical with the economic. In a world in which the majority of inhabitants are still very poor, this consideration,—the adjustment of technique to economy,—turns out to be of supreme importance.

Nowhere perhaps is this problem of economy more acute and the role of the engineer in raising the standard of technique more urgent than in our own country. India's poverty is a by-word. The standard of living of the country is amazingly low. The majority of the people live on the starvation level. You move with eyes open and you see poverty writ large on the face of the country. Our basic preoccupation—now that we have power to shape things in our own way—must be to eradicate this economic evil. This is our supreme problem and all other problems—whatever their immediate significance may be—are subservient to it. One often hears of mal-distribution of income, of concentration of wealth, of exploitation of labour and so on. These have their places; but they appear to be mere jargons in the context of an economy where even complete equalisation would leave a man with an income far less than what is necessary for just physical existence. It has been recently estimated that the barest minimum requirement of an individual in our country is Rs. 74|- per year at pre-war prices, whereas, according to the latest calculation, the actual income per head is no more than 65|- per year. Here I feel tempted to give you the results of an investigation recently done by the great statistician, Colin Clark of Australia, which would indicate to you the over-all economic position of India *vis-a-vis* the rest of the civilised world. To eliminate local peculiarities in respect of conditions of work etc., Colin Clark measures the real income of different countries by way of the quantity of goods and services obtained per man-hour of work done, and he then translates the goods and services in terms of a common standard of value,—the international unit, as he calls it. A comparison of man-hour productivity in international units then provides an idea of the relative economic position of the different countries. Here are his figures for the pre-war year.

Countries	Man-hour productivity in International units.
U. S. A.	1
New Zealand	0.87
Canada	0.75
Australia	0.59
U. K.	0.56
Germany	0.49
Holland	0.45
Sweden	0.40
France	0.40
Italy	0.21
Japan	0.19
Russia	0.18
India	0.07
China	0.03

Barring China, India is thus the poorest among the countries of the world whose income returns are available. This is not a frightfully surprising discovery. Yet it is worth while bringing the facts out in their nakedness. For, is not our tragedy—more pitiable than poverty itself—that we do not realise fully where we stand and what effort we have to put in to bring our economy to any thing like a civilised standard?

In a fifteen-year plan drawn up by a group of industrialists,—popularly known as the Bombay Plan—it has been estimated that if the income per head is to be raised just to double the present figure, we require an investment of capital of the value of Rs. 10,000|- crores at pre-war prices, and it has been further shown that not even half of this capital can be had during the assigned period from readily available sources. May I tell you that I have it on good authority that under existing possibilities even this estimate of our capital requirement does err on the side of moderation? Remember, the period is as long as fifteen years; the target is as modest as could be. And yet its achievement would need an amount of capital much too large to be supplied internally. There is of course the possibility of foreign loans. But foreign loans, as the wise would say, will involve foreign control which surely we cannot acquiesce in. Shall we, then, throw up our hands in despair? We must not do that. It does not lie in us—scientists—to do that. The estimates that I have mentioned are based on existing possibilities, and there is just one factor,—the potentiality of knowledge—that has been left out. Ours is the task of providing that,—of exploring new possibilities.

The effectiveness of a scheme of planning towards our objective requires a thorough collaboration between the Government, on the one hand, and, on the other, the industrialists, economists and scientists. It is clear that we can illafford to make mistakes, so hard pressed are we for economy. No doubt progress itself would imply some amount of trial and error, for we learn by failure no less than by success. But we must guard against avoidable error. Thoroughness, precision in working out details, scientific appraisal of the implications of each operation, care in the technical handling of projects—these are essential pre-requisites of the success of a scheme of planning. And nowhere are these more called for than on the engineering side. A slight error on the part of the engineer may plunge a plan into disaster. The failure of Tay bridge, for example, should be an eye opener to the Engineer. If there had been a more rigorous calculation of loads in all the members of the structure, what a tremendous waste would perhaps have been avoided! A slipshod way is inexcusable in an engineer. I shall just give you one example from my own line of how lack of attention to apparently unimportant details may often cause a disproportionately heavy damage. Suppose, while ordering for transformer for a high tension grid, you leave out just a small item like flux density in the core from your specifications and your manufacturer supplies transformers whose cores are worked at flux densities producing higher odd harmonics so as to cause flash over of transmission line insulators, the entire scheme will fail. This, I should mention, is not an imaginary possibility. It is based on my own knowledge of a certain unfortunate happening.

In this regard we would do well to take a lesson from the Great Tennesse Valley Administration. What an example of precision and thoroughness it is! What care the Administration has taken in filling in details before they started operation! There is no aspect either on the technical side or on the economic and social side about which the severest scrutiny has not been done in the plan. There is no detail which has been left out of the picture as unimportant. I shall give you a few illustrations showing the comprehensiveness of the T. V. A. plan. On the Transmission side, for example, specifications include poles, cross arms, pins, insulators and conductors hardware, pole hardware, guys and anchors, transformer installations, line sectionalising switches and fuses, grounding, electrical design of circuits connectors, service outlets of meter installations. Detailed drawings are given showing all conceivable operations in primary and secondary structures for 3-phase and single phase lines,—guys and anchors, transformers, boosters, primary meters, line switches, fuses, conductors etc. Instructions are also given in detail about various operations, *viz.*, tree trimming and clearances, method of determining proper size and location of transformers, regulations for motor service for outdoor meter installations, preparation of plans for wire crossing agreements over or under power lines, communication lines, railroads etc. On the utilisation side, too, each scheme has gone through the most rigorous scrutiny. Wiring and lighting the Farmstead, electric installation of poultry farms, use of power for utilising mineral resources, irrigation, soil erosion control—all these have been dissected into minute parts and each part has been subjected to the most stringent analysis.

I wish I could say the same thing about the corresponding enterprise in our country, the Damodar Valley Corporation. It is a great enterprise involving, we are told, a capital expenditure of Rs. 55 crores, and high hopes are being built on it in high quarters. I am afraid I have to plead almost complete ignorance about the affairs of the corporation and I do not know if the management is one of those State secrets, as they say. For, whereas on T. V. A. I could with little effort procure as many as 24 volumes containing analysis of the different parts of the scheme, including even a Manual of Secretarial Practice[1] on D. V. C. in which naturally I am more interested, all the literature that I could get, not without a considerable amount begging, is just a Preliminary Memorandum containing 40 pages of written matter tegether with a few Exhibits in which obviously nothing more than general principles could be incorporated. I do not know if the Secretariat possesses more comprehensive literature on the proposed activities of the corporation and I wonder why, if it does, the public at whose cost the corporation is being run and whose welfare it is supposed to be aiming at should not have access to it. However, in the absence of any detailed knowledge of the functioning of the scheme, I may make only a few tentative observations on certain aspects which deserve more searching analysis. Take, for example, Table I of the Memorandum (p. 12). The table gives the average rain-fall over the catchment area and the information that it contains can of course be utilised in determining Reservoir storage capacity. For the estimation of large floods, however, large storms on depth-time-area basis must be thoroughly studied.[1] From the average rainfall figures no definite conclusion can surely be drawn regarding the magnitudes of floods. The following data on a single storm given on p.13 of the Memorandum are interesting and instructive:

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[1] I should take this opportunity of recording my gratitude to the Librarian, Delhi all the available literature connected with T. V. A.
University Library, for the courtesy that he showed to me by placing at my disposal

Rainfall in inches	Period of precipitation	Run-off coefficient
11.8	Aug. 6 to Aug. 14, 1913	70%
9.6	Jul. 30 to Aug. 4, 1917	54%
9.8	Sept. 30 to Oct. 7, 1917	84%

From these figures it can be legitimately concluded that if a heavy storm of about 12 inches, as occured in 1913, were to occur in 1917 during the period, say, Aug. 14 to Aug. 20, the run-off coefficient would have exceeded 84%. The run-off coefficient of 90% as assumed in the Memorandum is thus reasonable enough. It may only be suggested that the probability of a large storm occurring within a short period should be investigated further from meteriological data.

Apart from the amount of rainfall there are other factors which must be taken into account in the determination of flood occurrences, *e.g.*,—the topography and the area of the catchment basin, the length and the ratio (length|mean breadth of the area), the intensity of the storm, the gathering speed of the flood and the various factors relating to it, travel of the storm, critical time, effective intensity of 'run-off' etc. I hope these matters have not been ignored by the authorities of the corporation; but I do not find much of a reference to them in the Memorandum itself. The Memorandum contains a few Exhibits. But they do not provide enough information to build a plan on. Exhibit No. 6, for example, gives only the weekly averages of the stream flow. But this surely is not enough to assist an investigator to estimate the maximum peak-flow. Exhibits 8 and 9 (Bar Diagrams) are useful no doubt. But the data available for flood discharge as shown in Table 3 (p. 14) are only for 11 years and cannot be relied upon as the basis of future estimates. Then again, if has been suggested that the 'Design flood' should be based on 50% increase on the maximum recorded peak flow, *viz.*, 65,000 cusecs as in 1913 and 1935. But this is a matter which needs further study by statistical methods for estimating, say, 100 years' and 1000 years' floods. I may mention that the flood of 1947 on the Mississipi river is reported to have been the largest in 103 years and to have exceeded the estimate. So also did the floods of the last year on the river Connecticut. The recent flood on the Ganges is also a case in point. Indeed in U.S.A. where an intensive study of flood frequencies and control methods has been made in a scientific manner, cases have been discovered where the actual peakfloods have exceeded the maximum. A thorough investigation in this line in our country is necessary if mistakes are to be avoided.[1]

On the utilisation side, the calculation is as much more important as it is more difficult. I may only indicate here a few lines in which estimates are urgent. In general the total estimated expenditure has to be weighed against the esitmated benefit to be derived from flood control. While, however, the expenditure is direct and capable of easy formulation, the benefit is not always so direct and definite, and the most careful analysis has to be made for its assessment. In a multi-purpose scheme such as the Corporation is intended to be, the potential benefits are many-sided no doubt, but potential risks are many-sided too. While flood-control—the chief objective of the scheme—would work as a protection against damage to harvests, homes, cattle, railway lines etc., the area upstream submerged in water on account of the construction of dams must be shown as a corresponding loss. While, again, the control measure will prevent soil erosion and facilitate irrigation, it will be accompanied by a certain loss of revenue from areas submerged by the big reservoirs. And there is the question of interest on the capital expenditure and time involved in the construction. All these possible losses must be balanced against gains if we are to have a correct appreciation of the economic and social implications of the enterprise.

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[1] For example of an analysis of the effect of the ration, length-mean breadth, on the gathering speed and on the ratio of actual Maximum to Probable Maximum flood peak, see P. C. 1934, paper No. 159.

I only hope these matters have not escaped the attention of our experts, although I am constrained to submit that evidence in this respect is not reassuring enough. In an administration such as the D. V. C. which ought primarily to be the concern of the Engineer, it is just this profession which remains as yet unrepresented. The old order takes time to change and we have yet the Civil Service to look after the affairs of our society!. This attitude must be revised. There must be a more judicious selection of technical personnel and wider recognition of talents if planning is not to be doomed to disaster. While I would plead for a conscious effort on the part of my associates to learn and to do their job properly, I am fully alive to their present-day disabilities. It is idle to expect much out of them if they are denied the facilities that are their due. An enviornment must be created in which they can thrive. And it is the Government which can do that.

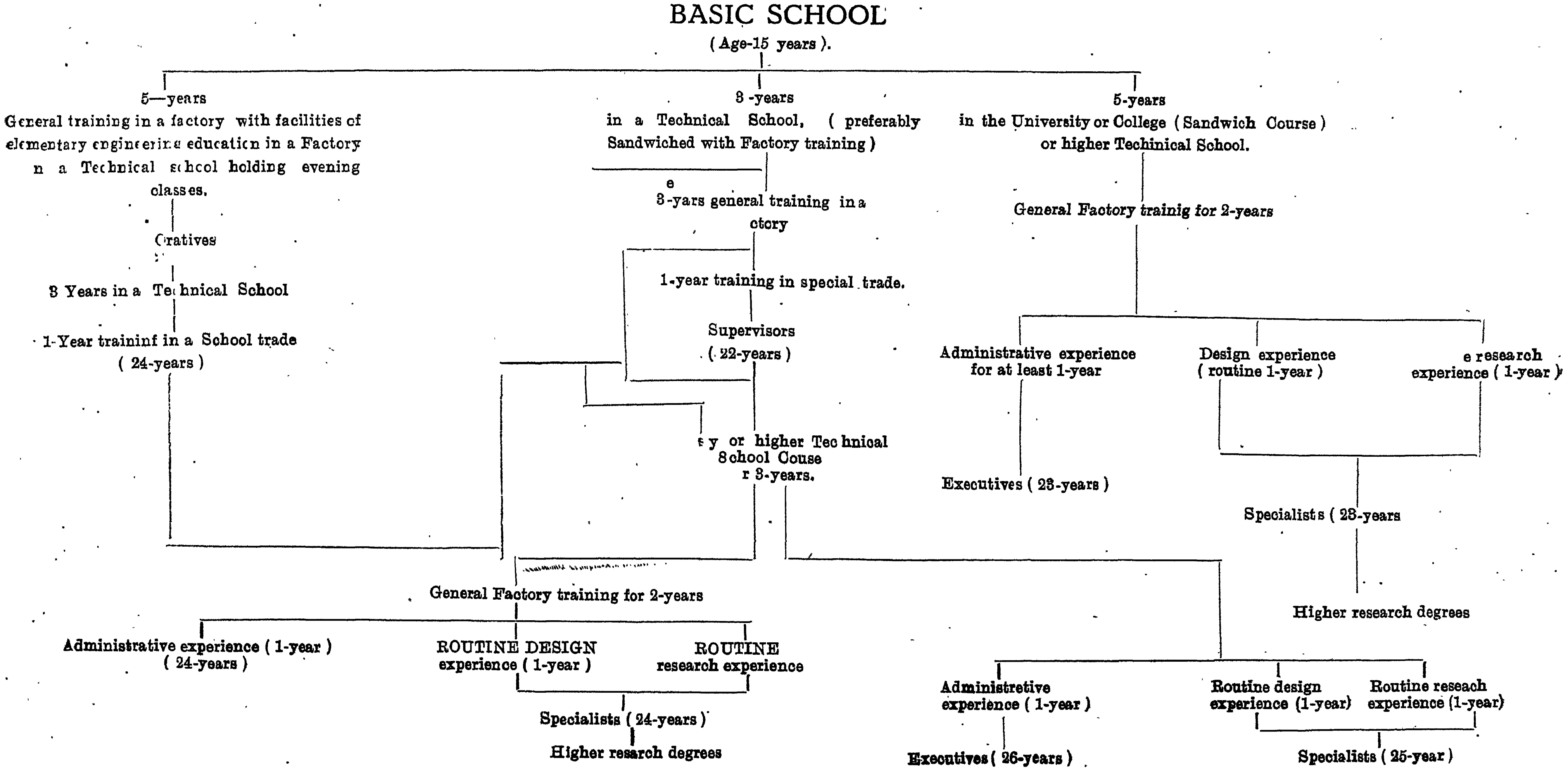
In putting Engineering in its proper place in the scheme of things, not only will the Government have to offer due recognition to the body of engineers as they exist today, they must also have to widen the facilities for engineering education. Engineering education, unlike we have had hitherto, must be broad-based on general culture, its sweep enlarged and its machinery moulded so as to give it a technical-liberal character if our future engineers are to play their legitimate role in shpaing the economy of our country. As one who has been associated with University Education in this line for well-nigh two decades, I may perhaps be permitted to say a few words on this important aspect. It is my painful experience that the basic training with which our students come in for engineering education in the University is far from satisfactory. Education of our boys must be thorough and concrete from the very beginning. For it is then that you can have the right men in your profession and take them along the right line.

The following scheme of education would seem in my judgment to meet our needs. In the elementary stage—for boys between 5 and 8 years—teaching should be based on the kindergarten system, so that it might correlate mind and body, develop the faculty of observation and also the power to control emotion. In the second stage—for boys of, say, 7 to 12 years—apart from the elementary study of basic subjects such as Arithmetic, Geometry, History and Geography—preferably through verses and elaborately illustrated by maps and globes—there should be a special exercise in memory through subjects which are interesting and stimulating. The boys may also be asked at this stage to take up simple handicraft, so that they may learn to use their brains and also to appreciate the dignity of labour. In the third stage—for boys between, say, 12 and 15—while there will be elementary teaching in basic subjects such as Language, History, Geography, Mathematics and General Science as there is at present, certain more subjects like Gardening, Carpentry, Weaving, Assembling of parts and making of designs may be introduced as electives, the choice being adjusted to the tastes and inclinations of the boys. Some form of psychological test may be applied for this adjustment. A scheme like this would help our boys in the choice of their career.

It is at this stage that ramifications will begin. One group will go from the Basic Schools straight to the factory and receive practical training in technical lines for 5 years. These will be Operatives. Lest they should not be deprived altogether of liberal education, facilities may be provided to these operatives for such education either through schools attached to the factories or through independent institutions if such exist in the neighbourhood. A second group will go to Technical Schools and receive theoretical as well as practical training there for 3 years and then finish up with factory training covering another three years. These will be Supervisors. Here also inside or outside factories, provision must be there for imparting education in theoretical scientific subjects for preserving freshness and initiative in our scholars. The third group will be our Executives. They will proceed from the Basic Schools straight to the University and undergo training in the various branches of Engineering and allied subjects for a period of 5 years. A certain degree of specialisation may be allowed in this five-year course, but in general the education here will have to be comprehensive and thorough. This course will also be followed by practical training in chosen lines in factories covering a period of 2 years. It is then that the education of our scholars will be complete. Specialisation in its true sense will come after this. For a few among these full-fledged engineers will be called upon to do research in special lines with a view to extending the range of knowledge, and facilities must be provided for such research work not only in our Universities but also in our factories.

I have endeavoured in the above scheme to indicate the minimum education needed in an Operative, a Supervisor and an Executive. This does not surely mean that the door of a higher order should be altogether closed to the lower group. On the other hand, I would plead for a large degree of flexibility in our system. An operative having had his training in a factory should, if he chooses, have access to the Technical School and if he finishes the 3-year course there, should have recognition as a supervisor. Similarly the University course should be open to the supervisor coming out of the Technical School, and since he will have already completed the 3-year course in the school, arrangement may be made by proper adjustment of the syllabus in the early courses of the University to give the qualified supervisor a concession of two years in his University studies. Here is a schematic representation of the status, standard and inter-relation of the various courses which will give you a full view of the plan, as I conceive of it.

Table show the minimum Educational qualification for technical personnel of different Cadres


BASIC SCHOOL
(Age-15 years).
5—years
General training in a factory with facilities of elementary engineering education in a Factory n a Technical school holding evening classes.
Cratives
3 Years in a Technical School
1-Year traininf in a School trade
(24-years)
3 -years
in a Technical School, (preferably Sandwiched with Factory training)
e
3-yars general training in a ctory
1-year training in special trade.
Supervisors
(22-years)
y or higher Technical School Couse
r 3-years.
5-years
in the University or College (Sandwich Course) or higher Techinical School.
General Factory trainig for 2-years
Administrative experience for at least 1-year
Design experience (routine 1-year)
e research experience (1-year)
Executives (23-years)
Specialists (23-years
Higher research degrees
General Factory training for 2-years
Administrative experience (1-year)
(24-years)
ROUTINE DESIGN experience (1-year)
ROUTINE research experience
Specialists (24-years)
Higher research degrees
Administretive experience (1-year)
Executives (26-years)
Routine design experience (1-year)
Routine reseach experience (1-year)
Specialists (25-year)

You will notice that the plan seeks at each stage to combine theory with practice. Both these are essential for the effectiveness of technical education. And since the machinery for the handling of technical details is already there in our factories, it is urgent that there should be a collaboration between our educational institutions and the factories. A synthesis of the two will make our technical education at once more effective and more economical. It is imperative, therefore, that our industrialists and factory owners should accept this responsibility and help us in this supreme task of training the future architects of our society. They must feel an obligation to do this. They draw upon the society and they must know that the society has a right to draw from them. Their capital, their machinery and their experience must serve this social need if they are to render a true account of themselves as partners in the building up of the nation. Of late there has been a tendency on the part of particular industrialists or groups of industrialists to introduce special technical courses to suit special requirements, and these are being paraded to the public as 'developmental' activity. This is deplorable, for it takes too narrow a view of things and is designed towards individual profit making. It stultifies scientific expansiveness instead of stimulating it. The practical training that our factories are called upon to arrange must be planned on standard basis and in this our industrialists have to take direction and guidance from academic men. Specialised training has its place, but it must come only after a young man has received a sufficiently broad-based education infusing in him an incentive for creation and a further understanding of human values. It is with a view to this that the endeavour of the academic man, the industrialist and the Government has to be directed.

We are a free people now. Our fate is in our hands. There is no longer an outsider to make a scapegoat of. Now, freedom implies responsibility, and unless each one of us is conscious of this responsibility and unless a conscious collective effort is made at utilising the objective conditions that freedom has created, the struggle of the last fifty years which has cost so many precious lives will prove meaningless. We owe to those noble fighters for freedom the best that is in us, and we shall be untrue to ourselves and to them if we do not exert ourselves fully to remove the misery and squalor of our land. We are inheritors of a big tradition, and yet looking back and feeding on past glories will not do. While deriving inspiration from the past, we must look ahead and lift our ancient land from the rut that it is.

JAI-HIND

Proceedings of the Thirty-Sixth Indian Science Congress

PART III—ABSTRACTS

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36th INDIAN SCIENCE CONGRESS, ALLAHABAD, 1949.

SECTION OF MATHEMATICS

President : Dr. S. Chowla

Abstracts

1. Bending of a $\perp$ — Plate.

B. R. Seth, Delhi.

Bending of rectilinear plates with supported edges and subjected to uniform pressure has been discussed in two recent papers. Plates with one or more re-entrant angles do not seem to have received any attention. In the present paper we discuss the bending of a $\perp$ - plate.

2. On Some Integrals Involving Legendre Functions.

N. G. Shabde, Jubbulpore.

In the paper 'On two definite Integrals involving Legendre functions' (*Proc. Benares Math. Soc.*. new series, Vol VII. 1945, pp. 51-53), the author has evaluated

$\int_{-1}^{1} (1+z)^{m+n}\, P_m\, P_n\, dz$ and $\int_{-1}^{1} (1+z)^{p}\, P_n\, dz$ for general values of m, n and p. In this paper these results are still further discussed and some more integrals, specially

$\int_{-1}^{1} (1+z)^{p}\, P_m\, P_n\, dz$, are evaluated.

3. On Real Continuous Solutions of Algebraic Difference Equations (II)

S. M. Shah, Aligarh.

I have discussed elsewhere ((i) *Bulletin Amer. Math. Soc.* 53, 1947, pp. 548-558; (ii) *Proc. Ind. Sc. Cong*, 1948, abstracts) the upper bounds of solutions of Difference Equations. In this paper I prove

Theorem. *If $y(x)$, a real continuous solution of an algebraic difference equation of the second order,* $P(y(x+2), y(x+1), y(x), x)=0$ *satisfies the conditions*

$$\log y(x) / \log x \rightarrow \infty \quad \text{as} \quad x \rightarrow \infty, \quad y(x+h) \geqslant y(x) / e_2(Bx), \quad 0 < h \leqslant 1, \quad x > x_0,$$

B *a positive constant, then* $y(x) < e_2(Ax)$ *for all* $x > x_0(A)$ *where* $A > B$ *is a positive constant depending on the given equation.*

A general theorem on Difference Equations of order m is also established.

4. The Vector form of an Invariant of Transformation.

K. Nagabhushanam, Waltair.

A transformation of Vectors is completely known if a transformation matrix is given or a triad of vectors a, b, c along with their transforms α, β, γ are given. The invariant *viz.*, of the Trace (or Spur) of the matrix is shown to be

$$\frac{ab\,\gamma + bc\,\alpha + ca\,\beta}{abc},$$

where each is a triple scalar product.

The author conjectures that it is not possible to express this invariant as a function of only the quarternions αa^{-1}, βb^{-1} and γc^{-1}, and their inverses.

5. On Compressible Fluid-Flow.

Ram Ballabh, Lucknow.

The paper discusses the conditions under which the velocity of a compressible fluid flow will be the vector sum of the velocities of two possible flows. The fluid is assumed to obey Boyle's law. The results obtained include as special cases some of those given by the author in an earlier work. (Superposable Fluid Motions, *Proc. Benares Math. Soc.*, 1940).

6. A Generalisation of Laplace Integral.

R. S. Varma, Lucknow.

In this paper, a generalisation of Laplace Integral is given, The theory is developed by the help of Whittaker Functions, and involves Stieltjes Integration.

7. A New Theorem for Finding the Factorial Moments of Certain Probability Distributions.

P. V. Krishna Iyer, New Delhi.

The r-th factoial moment of the Binomial Distribution is $r!^n c_r p$. This is the expectation of r things with probability p from n objects whose probabilities are either p or $1-p$.

For more complicated distributions the above result may be enunciated as follows:

The r-th factorial moment of a probability distribution is the sum of the expectations of the different ways of obtaining r of the desired combination of events or objects.

This method has been applied for finding the factorial moments of

(1) hypergeometric series.

(2) the probabilities distributions of the number of joins between points of the same or different colours arising from points of k coloms on a lattice.

8. Gauss Points in n-Dimensional Space.

S. R. Mandan, Kirkee.

There are in all $(n+1)!$ Gauss points. They all lie on a Quadratic-variety W and by $n-r+1$s in $\frac{n+1\ {}^{n+1}c\gamma}{n-\gamma+1}$ *i.e.* $\frac{(n+1)^2}{(n-\gamma+1)^2\gamma!}$ $(n-r)$-*flats* $(r=1,2,..\ n-1)$, in particular by ns in $(n+1)^2$ primes. These primes are faces of two sets of $n+1$ simplexes such that simplexes of one set are mutually perspective from the centroid of one of the given sim- plexes and the primes and of perspectivity pass through the centroid & a $(n-2)$-flat of the 2nd given simplex. The two centroids constitute a pair of conjugate points for W..

9. An Inversion Formula for Generalised Laplace Stieltjes Integral.

K. M. Saksena, Saugor.

In a recent paper Dr. R. S. Varma of Lucknow University has given a generalisation of the Laplace Stieltjes Integral involving Whittaker Functions.

I have in this paper investigated an inversion formula different from that given by Dr. Varma.

10. On a Generalisation of the Hankel Transform.

Ratan Prakash Agarwal, Lucknow.

At the last Science Congress at Patna I gave a generalisation of the Hankel Transform by using Maitland's generalised Bessel function. In this paper, I have further developed the theory of this generalised transform.

11. A Note on Hamy's Theorem.

N. L. Ghosh, Calcutta.

M. Hamy in 1889 proved the theorem that a heterogeneous liquid rotating in relative equilibrium about an axis cannot have an ellipsoidal density-distribution. The present note is a proof of the same theorem with a slight generalisation. The interesting point that is brought out here is that the proof does not depend on the form of the potential for a homogeneous ellipsoid. The method followed here does not require the potential function and therefore can be used to test the possibility of other forms of density-distributions. The gravitational field may be due to self-gravitation of the fluid together with an external field obeying certain restrictions.

12. On the Total Relative Strength of some Hausdorff methods equivalent to Convergence.

S. K. Basu, Calcutta.

In this paper, for a given sequence $\{s_n\}$, the transformation

$$\sigma_n = U\alpha\ \{s_n\} \qquad (n=0, 1, 2, ..)$$

is considered, where the matrix $U\alpha$ is defined by

$$U\alpha = \alpha E + (1-\alpha) H,$$

E being the identity matrix and H a suitable totally regular Hausdorff matrix. It is proved that, for $\alpha > 0$, $s_n \rightarrow l$ implies $\sigma_n \rightarrow l$ and conversely. With certain restrictions on the mass function $\phi(t)$ of H, it is proved that, for $\alpha < 0$, $s_n \rightarrow l$ implies $\sigma_n \rightarrow l$, but the converse is false. The question whether $s_n \rightarrow +\infty$ implies $\sigma_n \rightarrow +\infty$ and conversely is discussed. H=M, the arithmetic mean matrix gives the well known theorem of Mercer on limits (*Proc. Lond. Math. Soc.* (2), 5(1907), 206—24). Finally, the total relative strenght of two matrices U_α, U_β $(0 < \beta < \alpha)$ is compared, U_β being obtained similarly as U_α.

36th INDIAN SCIENCE CONGRESS, ALLAHABAD, 1949

SECTION OF STATISTICS

PRESIDENT : DR. U. S. NAIR, M.A., Ph.D., F.N.I.

Abstracts

Theoretical Statistics

1. On the Variance of Variance in the case of Finite Populations.

M. D. BHAT, Bombay.

A formula is developed and the magnitude of the variance is compared with that of infinite populations for various sample sizes.

2. Determination of the Confidence Belt of the Classical D^2-statistic.

P. K. BOSE, Calcutta.

It has been shown that the unbiassed and most powerful critical region based on the classical D^2–statistic is one tail end of the distribution. For (i) all alternatives $\lambda_2 > \lambda_1$ we have to consider the right-hand-side tail end and (ii) all alternatives $\lambda_2 < \lambda_1$ we have to consider the left-hand-side tail end.

Here starting with the unbiassed and most powderful critical region, 95% confidence belt for different values of L (for the two sets of alternatives) have been calculated.

3. Shape and Properties of Bessel Curves.

P. K. BOSE, Calcutta.

In this paper we have studied the shape of the Bessel Curve as we increase the values of the parameters.

Further, the possibility of using the Bessel Curve as a graduating curve for frequency data has been discussed.

4. On the Method of Group Averages in Estimation of Regression Coefficients.

V. J. CHACKO, Trivandrum.

The present paper is an extension of the method of group averages suggested by K. R. Nair in estimating regression coefficients from observational equations. The method of group averages consists in dividing the n residual equations into m sets of p, q, r, .. equations in number, and by equating the sum of the residual equations in each set to zero, we get m equations to solve for the m parameters to be estimated. K. R. Nair in a paper " On a simple method of curve fitting " (published in *Sankhyā* Vol. VI) obtained the values of $p, q, r, \ldots$ by maximising the efficiency of the coefficient of the highest power in the regression equation. S. S. Bose has (*Sankhyā* Vol. III) indicated several methods of estimating the regression coefficients.

In this paper, the joint efficiency of the estimates of the parameters is maximised with respect to p, q, r, . .. The case of a linear regression is worked out in detail and the working for higher degree polynomials, given in outline. The efficiencies of the estimates obtained by this method are compared with those obtained by the methods of K. R. Nair and S. S. Bose. The present method gives greater efficiency.

5. On the Ratio of the Mean Deviation to the Standard Deviation.

M. C. CHAKRABARTI, Bombay.

Let $n \geqslant 2$ and let $x_1, .., x_n$ be n real numbers, not all equal. Let $\bar{x}$ denote the mean and λ denote the ratio of the mean deviation from the mean to the standard deviation. The object of the paper is to give several proofs of each of the results :

(i) $\lambda \leqslant 1$,

(ii) Max $\lambda(x_1, x_2, .., x_n)=1$ if n be even and $=(1-1/n^2)^{1/2}$ if n be odd and

(iii) Min $\lambda(x_1, x_2, \ldots, x_n)=(2/n)^{1/2}$. The second and the third results are belived to be new.

6. A Note on Sampling from Finite Populations.

K. C. CHERIYAN, Bombay.

An expression for the error involved when sampling is done from a stratified finite population and an estimate of the population variance calculated on the assumption that the population is infinite, is derived in this paper. The function of the sample values which correctly estimates the population variance is also derived.

7. Determination of the best Shape of a Sample-cut.

ANUKUL CHANDRA DAS, Calcutta.

If s and s' be two quads in the cut with co-ordinates (x, y) and (x', y') respectively, then the correlation between them is $\rho(x-x', y-y')$ or in polar co-ordinates $\rho(r, \theta)$ $o \leqslant \theta \leqslant \pi$, $o \leqslant r \leqslant r_0$ (say). Variance of total yield of the cut is proportional to $\int \rho(r, \theta) ds\, ds'$, where ds and ds' are elements of area and the integration is carried over the cut. To find the best shape of all possible shapes of same area α, the variance is to be minimised. Let w_0 be a region or cut such that (i) inside w_0 : $\rho(r, \theta) \leqslant \lambda$ and (ii) outside w_0 : $\rho(r, \theta) \geqslant \lambda$; λ being so chosen that $\int\int\int\int ds\, ds' = \alpha^2$, when integrated over the region. Then this w_0 is the best cut. There may be w_0 such that (i) inside w_0 : $\rho_i(r, \theta) \leqslant \lambda_i$ and (ii) outside w_0 : $\rho_i(r, \theta) \geqslant \lambda_i$, $(i=1, 2, \ldots m)$ subject to the condition that $\rho(r, \theta) = \phi\{\rho_1(r,\theta), \ldots \rho_m(r, \theta)\}$ and $\lambda = \phi(\lambda_1, \ldots \lambda_m)$, λ being defined above. Thus we get a group of best cuts of which the best one is to be selected.

A cut whose shape is independent of the parameters in $\rho(r, \theta)$ is the uniformly best cut, which will depend on the correlopiped.

8. Non-null Distribution of Canonical Correlations.

ANUKUL CHANDRA DAS, Calcutta.

The non-null distribution in case of two groups with characters p_1 and p_2 (being unequal) was found out. It came out as a function of (p, q)th moment of binomial populations having the sample and population canonical correlations as their parameters multiplied by the non-null distribution portion.

9. Two Dimensional Systematic, Stratified and Random Sampling.

ANUKL CHANDRA DAS, Calcutta.

Definition of a kind of two dimensional systematic sampling is given. The field was supposed to consist of n arrays of strata along x and m along y directions, in all mn strata. Each stratum contains k arrays of cells along x and l along y, in all kl cells. In stratified sampling ν cells are taken at random from each stratum, in all sample of size $mn\nu$. In systematic sampling, ν cells are taken at random from the first stratum. Then starting from any of these chosen cells every kth array along x and on it every lth cell is taken, getting a sample of same size $mn\nu$. A random sample of size $mn\nu$ also can be taken, Let σ_r^2, σ_{st}^2 and σ_{sy}^2 be the variances of random, stratified and systematic samples respectively.

These variances were calculated and the following theorems were proved. Let $\rho(u, v)$ be the correlation between two points u, v apart and let it be positive.

Theorem 1. For all infinite populations in which:

$$\left.\begin{array}{ll} \text{(i)} & \delta_1^2\rho(u, v) \geqslant 0 \\ \text{(ii)} & \delta_2^2\rho(u, v) \geqslant 0 \\ \text{(iii)} & \delta_1^2\delta_2^2\rho(u, v) \geqslant 0 \end{array}\right\} \begin{array}{l} \delta = \mathrm{E}^{1/2} - \mathrm{E}^{-1/2} \\ \\ \mathrm{E}f(u) = f(u+1) \end{array}$$

$\sigma_{sy}^2 \leqslant \sigma_{st}^2$ for any size of sample; and $\sigma_{sy}^2 < \sigma_{st}^2$ unless equality holds in each of the above three cases.

Theorem 2. For all populations in which:

$$\left.\begin{array}{ll} \text{(i)} & \Delta_1\Delta_2\rho(u, v) \geqslant 0 \\ \text{(ii)} & \Delta_1\rho(u, v) \leqslant 0 \\ \text{(iii)} & \Delta_2\rho(u, v) \leqslant 0 \end{array}\right\} \Delta = (\mathrm{E} - 1)$$

$\sigma_{st}^2 \leqslant \sigma_r^2$.

Theorem 3. Under conditions of theorems (1) and (2), $\sigma_{sy}^2 \leqslant \sigma_{st}^2 \leqslant \sigma_r^2$.

10. On a particular type of Natural Field.

BIRENDRANATH GHOSH, Calcutta.

In a uni-dimensional field, under the condition (no. 1) that the partial spatial correlation between any two points A, C, for a given intermediate point B, is zero, the spatial correlation $r(u)$ for an interval of length u, takes the form $exp(-gu)$, using the positive numerical value of u, obviously (Bojarski, 1941). This form has been observed in some natural fields (Osborne 1942). Matern (1947) has generalised the form to $r = \Sigma p_i exp(-g_i u)$, $(\Sigma p_i = 1 ; p_i, g_i \geqslant 0)$, for which however the condition no. 1 breaks down.

In a two-dimensional field with directional heterogeneity, suppose the x and y axes are chosen along two principal orthogonal directions (*e.g.*, along and across the rows in a crop-field where the plants are sown in rows). In such a field, if, besides condition no. 1 holding along both the x and y directions separately, there is another condition (no. 2) that the partial correlation between the points D, F for a given point E is zero, when D, E, F are so arranged that DE$=u$ along x and EF$=v$ along y, then the spatial correlation $r(u, v)$ comes out in the form $exp(-gu-hv)$. This form can also be generalised to $\Sigma p_i exp(-g_i u)\Sigma q_j exp(-h_j v)$, i running from 1 to k, and j from 1 to k'; $(\Sigma p_i = \Sigma q_j = 1 ; p_i, q_j, g_i, h_j \geqslant 0)$; for this form condition (2) holds, but condition (1) breaks down. The forms of r for the unidimensional fields can be derived from the corresponding forms for two-dimensioned fields, simply by putting $v=0$. The simpler forms for both unidimensional and two-dimensional fields can be derived from the generalised forms of r by putting p_i, q_j equal to 1 for $i=j=1$, and equal to zero for other values of i and j.

11. Variance and Covariance of Rectangular and "Linear" Sample-units for a type of Natural Field.

BIRENDRANATH GHOSH, Calcutta.

Let V(X, Y) be the variance of a rectangular sample-unit (s.u.) with sides X and Y along the x and y directions, for a density-like variate (like yield per acre, proporton of land under crop, population density, etc.). If the spatial correlation $r(u, v)$ be of the form $\Sigma p_i\, exp(-g_i u)\, \Sigma q_j exp(-h_j v)$, with u, v along the x and y directions respectively, and σ^2 represents the variance of the basic cells in the field, then $\mathrm{V(X, Y)} = \sigma^2\, \Sigma p_i\, \phi(g_i, X) \times \Sigma q_j \phi(h_j, \mathrm{Y})$, where $\phi(a,b) = \frac{2}{ab}[1 + \frac{1}{ab}\{exp(-ab) - 1\}] = 2\,\{1/2\,! - ab/3\,! + (ab)^2/4\,! - (ab)^3/5\,! + \ldots.\}$ For the similar case for unidimensional field, a "linear" s.u. of length X, $\mathrm{V(X)} = \sigma^2\, \Sigma p_i\, \phi(g_i, \mathrm{X})$

In the two-dimensional fields, let us take two "linear" s.u.'s of lengths L, M (parallel to the x axis) whose nearest points are separated from each other by a distance s

in the x direction and d in the y direction. Then the covariance between these two s.u's will be given by

$$\sigma^2 \Sigma q_j \, exp(-h_j d) \, \Sigma p_i \, \psi(L, M, C, g_i),$$

where
$$\psi(L, M, c, g) = \frac{1}{LMg^2} exp(-gc)\{exp(-gL)-1\}\{exp(-gM)-1\},$$
$$= exp(-gc)\{-1+gL/2!-(gL)^2/3!+\ldots\}\{-1+gM/2!-(gM)^2/3!+\ldots\}.$$

By putting $d=0$, we get the two "linear" s.u.'s lying on the same line; $d=0$ also gives the case for unidimensional field.

12. Methods of deducing the Normal and the Poisson Distributions as Approximations to the Binomial.

M. V. Jambunathan, Calcutta.

It is usual to show that the Normal Distribution as well as the Poisson Exponential can be derived as approximation of the Point Binomial. Most of the text-books (*e.g.* Yule and Kendall's book) employ Stirling's approximation to $n!$, though it is possible to arrive at the same results by simpler algebraic methods without resort to Stirling's formula. It is claimed that this method is no less rigorous than any that is usually employed.

13. Estimation of Parameters from Incomplete Data with application to Design of Sample Surveys.

A. Matthai, Calcutta.

In this paper it has been shown that improved estimates can be obtained from incomplete data when the data relate to correlated variables. For a population characterised by two measurements a sample may consist of $N=n+n_1+n_2$ individuals, n_1 providing the first measurement alone, n_2 the second alone and n both. A parameter like the mean, say for the first measurement, can be estimated from the set of $n+n_1$ observations only. Assuming, however, normal distribution for the measurements, the maximum likelihood estimates obtained by taking the whole sample into consideration, have been shown, in case of correlated measurements, to be more accurate than those obtained from individual sets of sample values. Similar estimation in the case of more than two variables has been indicated with example.

The utility of this technique in designing sample surveys has also been brought out with the help of example. The optimum number of common sample-units to be retained in "second" and later surveys has also been derived.

14. A Note on a Distribution related to the Wishart Distribution.

K. Nagabhushanam, Andhra.

In this note a straight and short proof, based on tensor ideas, is given for the functional form (F), given below, recently obtained by G. Rash, of the Distribution Function of the product moment matrix of Wishart's n-vector distribution in a space of k dimensions.

$$p(M)=C\,\phi^{\frac{n}{2}}\,e^{-\frac{1}{2}\sum_{ij}\phi_{ij}M_{ij}}\,M^{\frac{n-k-1}{2}}. \quad \ldots\ldots\ldots\ldots(F)$$

15. Sequential Tests for Regression Problem.

H. K. Nandi, Calcutta.

It was observed in a previous communication that for testing the significance of simple and multiple regression co-efficients in a sample of fixed size the first kind of error can be controlled independently of the distribution of certain variables, and the second kind of error also remains the same in a wide class of distributions of these random variables. If sequential tests based on the ratio of conditional probabilities are used, both the first and second kind of error are controlled at given levels independently of the distributions of certain random variables. Though two points on the OC curve are thus controlled, the other points are affected by the distribution of these variables. However, certain two sample tests can be formulated which will make the power function independent of the variables in question.

16. Precision of the Estimates of the Components of Variance.

P. B. PATNAIK, Madras.

The difference between the 'random' and 'systematic' set-ups in the analysis of variance is considered with regard to the parameters involved. It is, however, shown that situations exist where the variability of the means of a set of units, which form the whole finite population, has a practical significance. Then this component of variation assignable to a systematic factor has to be estimated from the analysis of variance table, as also that assignable to a random factor. Methods of measuring the reliability or precision of these estimates are examined in this paper. The distributions of these estimates in the forms of (i) $a\chi_1^2 - b\chi_2^2$ in the random case and (ii) $a\chi'^2_1 - b\chi_2^2$ in the systematic case are obtained. The method of confidence intervals for measuring the reliability of an estimate is then discussed. It is found that a systematic component of variance can be estimated with much higher precision than a random component.

17. On the Distribution of the Ratio of two Ranges in Samples from Normal Population.

K. C. S. PILLAI, Trivandrum.

If x_1 and x_n are the smallest and largest observations in a sample of size n from a normal population,

$$w = x_n - x_1$$

gives the range. The distribution of $F' = (w_1/w)$ where w_1 and w are the ranges in two samples is studied in this paper. It will be noted that F' may be taken as a test for equality of variances.

The 5% and 1% significance limits for F' are tabled for values of n_1 and n_2 ($<$ 10).

18. The General Theory of Fractional Replication in Factorial Experiments.

C. RADHAKRISHNA RAO, Calcutta.

The general theory of symmetrical factorial designs has been considered in detail by Bose, Kishen and Fisher. All the designs constructed by them can be made to depend on the combinatorial arrangements known as *hypercubes of strength* '*d*'. In the present paper it is shown that these arrangements can also be used in the design and analysis of Fractional Replications.

The practical problem is the construction of a design using only a subset of the treatment combinations so as to admit the measurability of main effects and first order interactions unaffected by the presence of interaction up to the order $(d-1)$. It is shown that a set of sufficient conditions for the existence of such a design is (i) the subset of treatment combinations used is a hypercube of strength $(d+1)$ and (ii) each block of the design is a hypercube of strength 2.

Inequalities have been derived connecting the maximum number of factors that can be used and the other parameters of the design. Some useful designs have been listed.

Applied Statistics

19. On Curve Fitting for Meteorological Data.

M. D. BHAT, Bombay.

The relation between rainfall and temperature, sunshine and temperature, and the adequacy of the representation of rainfall and sunshine by orthogonal polynomials have been examined.

20. A Note on Designing Family Budget Surveys.

S. BHATTACHERYYA, Calcutta.

The paper is based on the enquiry into the family budgets of the middle class of Calcutta in 1945. The object of the paper is to study the correlation between two families living in the same house with regard to one of the most important features determining the economic status of the families, *viz.* the total family expenditure per month, and to show that if the correlation is not significantly high a great economy can be effected by including into the sample for future study a larger number of families from a fewer number of houses.

21. A Note on the Study of the Variations of the number of tablets per pound of Quinine Ammonium Sulphate.

CHAMELI BOSE, Calcutta.

An experiment was conducted at the cinchona plantation, Mungpoo, during the year 1944-45, to study the variations of the production of tablets per pound of Quinine Ammonium Sulphate.

Shewhart's quality control technique was used in analysing the data and it was found that the production of tablets was not under control. Several suggestions were made regarding the future planning of this type of experiment.

22. On Sample Checking of Coded Census Slips.

H. K. CHATURVEDI, Calcutta.

The paper describes the method and efficacy of a system of sample-checking recently introduced in the Indian Statistical Institute in the case of transferring to Hollerith cards the 1941 census sample slips. The slips number about 60 lacs and on each slip 21 items of information are coded for the purpose of preparing census tables with the help of Hollerith machines. When the volume of work is huge, it considerably saves both time and money if checking of the coded slips is not done hundred per cent but is reduced to its minimum consistent with the standard of accuracy. The principle underlying the system is to check thoroughly the slips in which the number of mistakes is found to be higher than the number of mistakes which can be tolerated and to check only a portion of the slips in which the number of mistakes is found to be lower than the tolerance limit. The actual working process, to which a lot (about 200 slips approximately) of coded slips is subjected, covers many stages of checking, the first being the checking of 25 per cent of the slips. It has been found that the desired accuracy is ultimately reached by checking only about fifty to sixty per cent of the total volume of the slips depending on the nature of the information recorded.

23. Route Sampling for Estimation of Cropped Area.

D. M. GANGULI, Calcutta.

Samples of size 2.25 acres have been generally used by the Indian Statistical Institute for estimation of the areas under major crops in Bengal. In case of minor crops, however, it was felt that relatively larger numbers of bigger sized samples would be necessary which would mean higher and in certain cases almost prohibitive costs. A small scale experiment was conducted to test an alternative and prima facie much more economical technique which is supposed to be applicable to all crops major or minor. Encouraging results were obtained, but more experiments would be needed before one could make safe recommendations. The details of the technique are indicated below:

A line was drawn in the village map joining the approximate centres of two plots having the highest and lowest plot numbers. The investigator was to cover this line across the village by walking along boundaries (*ails*) of the plots keeping as near to the line as possible. While thus walking he was to always look to the right (or left) and count and record the number of steps he took while walking along a particular type of land (land under wheat, land under pulses, fallow etc.) and then again along land of some other type and so on till the end. The total distance (counted in steps) thus covered was related to the sample (village) area, while the percentage of the number of steps taken along any particular crop to the total number of steps taken was related to the percentage of that crop in the whole village.

24. A Note on the Size of Marginal and Economic Holdings in Bengal.

A. Ghosh, Calcutta.

The object of this note is to lay down the concepts and a statistical method of determining precisely the 'marginal' or 'minimum' and 'economic' size of holding, in cases where the agricultural economy presents a state of transition from subsistence to fully competitive economy, from certain a priori considerations involving certain realistic assumptions about the institutional factors. These concepts are thus sought to be fixed 'empirically' and freed from all possible subjective bias. The method used has been to fit appropriate curve to the area 'owned' and 'cultivated' and to deduce from the nature of the curve the 'optimum' holding as also a minimum holding.

25. On Estimates of Population of the Dominions of India and Pakistan for the year 1951.

G. V. Krishnaswamy, Annamalai.

In this paper, the author discusses different methods of estimating population figures for Provinces of India and Pakistan and gives the estimates for the year 1951.

26. A Sample Survey for Estimating Requirements of Potato seeds in West Bengal.

N. T. Mathew *and* D. M. Ganguly, Calcutta.

A large proportion of the potato seeds used for cultivation in West Bengal is imported from other provinces. For regulating this import and for ensuring proper distribution of potato seeds at the sowing season it is important to have reliable estimates of the total requirements of the different varieties of potato in the different districts. A sample survey for obtaining this information was conducted in the crop season of 1947-48 by the Indian Statistical Institute. This paper gives an account of the survey and the results obtained.

27. A Note on the Size and Shape of Cuts in Crop-Cutting Surveys.

N. Gopalakrishnan Nair, Trivandrum.

In crop-cutting experiments, the usual assumption is that the yield from a cut is a random variable. The yield from a cut depends upon the number of plants in the cut and also on the yield per plant. Assuming that the plants are situated at equal distances and that the yield per plant remains constant, the yield from a cut varies because of the variation in the number of plants within the cut. This variation is studied in this paper.

The number of plants in a cut varies due to (1) shape and (2) random location of the cut. It has been shown that the circular cuts show minimum fluctuation in the number of plants due to random location. The expectation of the number of plants is equal to the area if the distance between plants is the unit of measurement whatever be the shape of the cut.

28. Technique in the Analysis of Financial Statements of Joint Stock Companies.

V. G. Pendharkar, Bombay.

The financial statements and balance sheets issued annually by the joint stock companies under the Indian Companies Act contain a wealth of data of considerable interest to the economic statistician. Properly analysed they would yield valuable information on a number of aspects of the capital market. However, there are two main difficulties in the way of the statistician. In the first place, the data are too numerous and secondly, owing to different accounting practices the meaning and composition of different items differ from one balance sheet to another. The first difficulty can be solved by sampling, subject, of course, to the second consideration.

Since the main interest in such analysis is the estimation of various totals such as total depreciation allowances or total funds raised from short-term borrowing etc. a stratified sample with a suitable cut-off line appears to be most useful. The choice of an appropriate variable is most important here. In the paper presented the actual technique used and the results obtained in the case of a fairly homogeneous and small population are discussed.

29. A Sampling Investigation into Physical Measurements and Tests of Efficiency.

D. V. Rajalakshman, Madras.

In order to fully achieve the aims and objectives of physical education in schools, it is essential to evolve a scientific procedure for studyig the physical attainments of school children. Since the performance of boys in efficiency tests framed to study their physical attainments depends on their age and physical measurements besides individual ability, a proper approach is to classify them into homogeneous groups based on a reliable index and set separate standards of performance for tests to each group. Although, at present, some empirical formulae are in vogue, reliable basis of classification suitable for Indian conditions is not available. As a preliminary step to attain this objective a sampling investigation has been conducted into the physical measurements and efficiency in performances of 1,481 school boys in Madras.

This paper embodies the results of this sampling enquiry. The collected data have been utilised to study the relationship between age and different physical measurements like height and weight, and their bearing on the performances. Attempts have also been made to provide the basis for the classification of children into homogeneous groups for fixing standards of performance to each group in tests of efficiency.

30. Indian Economy under Inflation.

T. Ghosh, Calcutta.

In this paper the general principles of Indian Economy under inflation has been discussed. Author has further discussed the Government of India's anti-inflationary plan.

36th INDIAN SCIENCE CONGRESS, ALLAHABAD, 1949.

SECTION OF PHYSICS

PRESIDENT : DR. R. S. KRISHNAN, M.A., D.Sc., Ph.D. (Cantab).

Abstracts

1. On Sound Absorption in Liquids.

R. N. GHOSH *and* GURUDEV SHARAN VERMA, Allahabad.

This is a preliminary report about the measurements of absorption of sound in liquids in the ultrasonic region with an ultrasonic interferometer. This is based upon noting the reaction of the reflected waves on the vibrating crystal as the reflector is approached to or withdrawn away from the source.

Preliminary measurements were first of all taken in air to test the apparatus. The results have been found to be in excellent agreement with the expected theoretical values.

Measurements in the case of Benzene yield for the 'frequency free' coefficient of absorption $\alpha/N^2 \times 10^{17} = 940$ approx.—a value which is about 100 times the value which is explained by viscosity and heat conduction.

Investigations in the case of transformer oil give $\alpha = .00208$ cm^{-1}.—a value which can be explained by viscosity alone.

With acetic acid the work is being continued at the time of writing; it is hoped to work with different frequencies.

2. Dispersion and Absorption of Sound in Gases.

S. K. K. JATKAR *and* D. LAXMINARAYANAN, Bangalore.

A theory to account for the observed dispersion and absorption of sound at low frequencies has been advanced. It is found that molecules with anisotropic Van der Wall's fields can oscillate in the field of one another and the frequency of vibration is given by $\nu = \frac{1}{2\pi}\sqrt{\frac{E}{I}}$ where E is of the order of Van der Wall's energy of attraction and I the moment of inertia of the molecule. It is found that this oscillation can account for the dispersion of sound and absorption of sound at low frequencies. The frequency region calculated from the above equation agrees with that found by experiment in order of magnitude in all the cases. The quantities E have been calculated from London's equation for Van der Wall's interaction in terms of optical frequencies. This gives the link between the acoustical dispersion and optical frequencies even though they by themselves differ by several orders of magnitude. Calculations using Slater and Kirkwood's formula for Van der wall's forces also give results in agreement with the acoustical frequency of dispersion.

3. Effect of Increasing Length of the Sound Wave on Ultrasonic Diffraction at 35 Mcs.

B. RAMACHANDRA RAO, Waltair.

Progressive sound waves of frequency 35 Mcs/sec are set up in a long column of water using a 2″ length quartz crystal with a fundamental frequency of 1.2 Mcs/sec, excited by an oscillator employing Taylor T–55 valve. The usual Debye-Sears arrangement is used for obtaining the first order diffraction lines for normal incidence and their intensities estimated visually for different lengths of sound field, the length of the sound beam being varied by an air-film enclosed between two glass plates whose position is noted by an index moving on a millimetre scale. The intensities of both the first order diffraction lines exhibited a periodic fluctuation, the distance between successive minima being 9mm in agreement with the theoretical value of 8.4 mm obtained from expressions given by Nath, Rytov and David. The experimental results do not fit into the theory in the respect that the intensity of the first orders do not go through minima of zero. This was explained as due to the progressive damping of the sound wave due to the high absorption by the liquid at these frequencies.

4. Apparent Non-Ohmic Nature of Electrical Conduction in Single Crystals of Molybdenite.

Ajit Kumar Dutta, Calcutta.

For currents both along and at right angles to the basal plane of molybdenite single crystals, the current-voltage relation has been found to be non-Ohmic. This non-Ohmic nature of current-voltage relation vanishes when the crystal is heated to about 150° C. This has been explained to be nothing but an effect of rectifying action of the crystal which vanishes with the rise of temperature. This explanation is further shown to be qualitatively supported by the findings of all theoretical investigators on rectification.

5. Dielectric Dispersion of Water.

S. K. K. Jatkar *and* B. R. Y. Iyengar, Bangalore.

The data of recent measurements on the dielectric constants and loss angle of water at different temperatures and frequencies has been used to calculate the critical frequency and molecular radius of water, by applying the new equation for dielectric dispersion of polar liquids. A temperature independent value of 1.4 Å is obtained for the molecular radius in agreement with the accepted value.

6. Dielectric Dispersion of Polar Solutions.

S. K. K. Jatkar *and* B. R. Y. Iyengar, Bangalore.

An expression has been derived for the dielectric dispersion of polar solutions taking into consideration the individual orientations and relaxation times of the molecules of the polar components. Oncley's semi-empirical relationship which has been applied to solution of proteins is shown to follow from the new equation, after effecting certain valid approximations. It has also been pointed out that the equation used by Collie, Hasted and Ritson to interpret the dispersion of aqueous ionic solutions is erroneous.

7. Kerr Constant of Liquids.

S. K. K. Jatkar *and* B. R. Y. Iyegnar, Bangalore.

The Kerr Constants of nonpolar liquids have been interpreted on the basis of the new relationship

$$B = \frac{3\pi N}{\lambda}\left[\frac{1}{15KT}\{(\alpha_1-\alpha_2)^2+(\alpha_2-\alpha_3)^2+(\alpha_3-\alpha_1)^2\}+\frac{1}{15K^2T^2}\{(\mu_1^2-\mu_2^2)(\alpha_1-\alpha_2)\right.$$
$$\left.+(\mu_2^2-\mu_3^2)(\alpha_2-\alpha_3)+(\mu_3^2-\mu_1^2)(\alpha_3-\alpha_1)\}\right]$$

which has been derived using the new law of polarisation $(\varepsilon-1; n^2-1)$ in place of the Clausius-Mosotti law $\left(\frac{\varepsilon-1}{\varepsilon+2}; \frac{n^2-1}{n^2+2}\right)$ and taking into account the restricted freedom of orientation of molecules in liquids. The Kerr constants of benzene, carbondisulphide, toluene, ortho, meta and para xylenes, napthalene (nonpolar); chlorobenzene, chloroform, nitrobenzene, ether and acetone (polar) calculated by the new equation using the polarizability values and other anisotropy constants obtained from vapour data show agreement with the observed values. The values calculated by Langevin-Born formula show wide deviation from the observed value. The new equation also satisfactorily explains the temperature coefficient of the Kerr Constants of liquids.

8. Dielectric Constants of Tourmalines.

D. A. A. S. Narayana Rao, Waltair.

The dielectric constants of yellow tourmaline, rose-red tourmaline, dark-green tourmaline, and a number of black opaque tourmalines are determined by a liquid mixture method at a frequency of 1.6 Mcs and a temparature of 28°C. The values obtained for different coloured specimens are different. In the case of the black specimens, which are of the iron type, there is a regular variation of the dielectric constant in any direction with density.

9. Faraday Effect in Crystals and Solution : Potassium Alum.

S. Ramaseshan, Bangalore.

The Faraday effect and the Magneto-optic anomaly in single crystals and solutions of potassium alum have been measured for the wave lengths λ 5893 and λ 5461 and it is found that while the value of magneto-optic anomaly of the crystal is 53.3%, that for the different solutions is of the order of 75%. The anomaly decreases with decreasing concentration.

10. Nuclear Magnetic Resonance and the Effect of the Methods of Observation.

G. Suryan, Bangalore.

In this paper factors affecting the time required for nuclei precessing in a magnetic field to lose their energies to the surrounding medium have been investigated and calculations performed. It has been observed that the present methods of observing either nuclear magnetic absorption or nuclear induction involving the placing of the sample in a resonant circuit gives rise to losses from the nuclei in times of the order of a second. Calculations for the same have been performed both on the picture of circuit theory and on the picture of precessing nuclei. That the presence of the circuit can affect the observed nuclear relaxation times to a considerable extent is apparent. This is of utmost importance in finding the true relaxation times due to either spin-spin or spin-lattice interaction. Results indicate that the effect of the resonant circuit depends on the Q of the circuit. It is therefore possible to test these results by means of experiment. It is also found that the presence of some loosely bound electrons in ionic crystals is likely to have a large effect in the observed short relaxation times. These may to some extent clarify the unexpectedly short relaxation times found in certain crystals like LiF even at very low temperatures.

11. A new method of observing Nuclear Paramagnetic Absorption.

G. Suryan, Bangalore.

A new method of using the autodyne detector for nuclear paramagnetic absorption has been developed. The requirements for a sensitive detector are (1) the power level should be low, (2) high R.F. amplification must be possible. In the ordinary autodyne detector these requirements are not fully satisfied because of high instability when low power levels are approached. In the present method low power levels have been obtained by the use of harmonics of an oscillator which is just oscillating. This leads to elimination of most of the disadvantages of the autodyne detector and the sensitivity is quite high. A reciever followed by a cathode-ray tube indicator was used as usual to facilitate observation. With this apparatus a week resonance due to metallic copper (spin 3/2) has been observed. Also it was found that a very weak but observable absorption corresponding to an absorption of quanta of energy $h(2\nu)$ at a given value of magnetic field takes place. Whether this is due to the taking place of forbidden transitions or due to the method of observation has to be determined by further experiment. Limitations in the way of using this method are the requirements of very steady and very uniform magnetic fields; otherwise very unsteady oscilloscope patterns result.

12. The Oscillatory Motion of the Space Charge Sheath in Phase with the Exciting Voltage: A probable cause of the *Joshi-Effect*.

H. J. Arnikar, Banaras.

Photoelectric emission from the boundary layer formed by adsorption of ions and excited molecules produced under the discharge is postulated by Joshi as the primary factor of the above effect, (S. S. Joshi, *Curr. Sci.*, 1945, *14*, 175; and *ibid*, 1947, *16*, 19). In the present theory it is assumed: (i) that a negative ionic sheath is formed as a consequence of this emission, and (ii) that this sheath can oscillate coaxially between the electrodes in phase with the voltage of the H.T. electrode, as the latter acts alternately as a pro- and anti-biassed grid to the sheath. Two such sheaths can be formed, one from each electrode boundary layer. Of these, the one emanating from the L.T. (outer) electrode is regarded, under conditions of maximum *Joshi-effect*, as relatively stable and coextant with irradiation, in consequence of a presumable dynamic equilibrium between the ion-removing and adding processes from and to the sheath. In the case of the similar boundary layer on the surface of the H.T. (inner) electrode, however, photoemission being not possible during at least the positive half of the cycle, the corresponding space charge sheath can only be intermittently formed, whose general effect will be to make the oscillations of the stable sheath (the first one) asymmetric in the two consecutive half cycles. Further, the synchronous movements of the charge sheaths in phase with the voltage may be expected to include besides the A.C. input frequency and its harmonics, (certain) high frequencies possibly extending up to the R.F. range. The interference of these latter with the H.F. components shown earlier by Joshi (*Nature*, 1944, *154*, 147) to be present in the discharge current must be regarded more or less complete to account for the large suppression of the current caused by irradiation. Similar suppression of the current due to the heterodyning of frequencies of different ranges has been previously reported, (G. S. Tiwari, *Proc. Ind. Sci. Cong.*, 1946, *Phys. Sec.*, Abst. No. 31).

The observed decrease in the magnitude of the *Joshi-effect* $(\%\Delta i)$ with the increase of gas pressure and temperature, as well as with the input frequency of the exciting field, and the voltage above the optimum value, are shown to be necessary corollaries of such a hypothesis. Further, while the formation of the sheath immediately follow the capture of the emitted photoelectrons by the gas molecules (and/or atoms) of the excited gas, its removal is a relatively slower process, as the destruction of the sheath has to be effected by the continued kinetic-molecular, and ionic agitations against it. This anticipation from the present theory is borne out in practice by the finding that the ratio of the times for current recovery in dark and its suppression under light is slightly, but distinctly, greater than unity, especially under conditions of maximum *Joshi-effect*.

13. The *Joshi-Effect* in Air.

H. J. Arnikar, Banaras.

By using a specially large size Siemens' glass ozoniser with a total electrode sur-ace of about 12,000 sq. cm., it has been possible to obtain in dry and CO_2-free air as arge as 95% negative *Joshi-effect*, in marked contrast to the low values (about 3% or ess) reported by the earlier workers, (G. S. Deshmukh, *Journ. Ind. Chem. Soc.*, 1947, *4*, 211; and K. V. Rao, *Proc. Ind. Acad. Sci.*, 1948, *27*, 72). At given irradiation and oltage, increase of gas pressure and frequency of the A. C. supply generally lowered he % *Joshi-effect*. Thus, raising the pressure from 2.5 to 100 mm Hg lowered the rela-ive *Joshi-effect* from 95 to 30% (50 cycles frequency), and changing the frequency om 50 to 500 cycles per second reduced the *Joshi-effect* from 95 to 62% (2.5 mm. g pressure). Under constant gas pressure and A. C. frequency, the *Joshi-effect* rises a maximum just above the threshold potential, V_m, and for further increase of voltage, the *Joshi-effect* diminishes rapidly at first and then more slowly. Thus, at a pressure of 2.5 mm Hg, and A.C. frequency of 50 cycles, the *Joshi-effect* rises from 75% at the threshold potential of 0.23 *k*V, to 95% at 0.30*k*V. It then falls to 15% at 0.60 *k*V and finally trails off to about 1% at 3.0 *k*V.

In the case of A.C. frequency of 500 cycles, the negative *Joshi-effect* changed over to a small positive effect at a certain voltage, the negative and positive effects being sharply potential reversible. This critical voltage rose from 0.88 to 2.09 *k*V for raising the pressure from 2.5 to 48.5 mm Hg.

In marked contrast with the halogens and mercury vapour, air showed a diminishing *Joshi-effect* with prolonged ageing under excitation. Concomitant with this was noted a partial disappearance of the gas. The adsorption involved in this clean up, if regarded as constituting a secondary layer over the initially formed photoactive layer of Joshi's postulate (*Curr. Sci.*, 1945, *14*, 175), a simple explanation of the detrimental influence of ageing becomes possible.

14. Production of the *Joshi-Effect* in Selenium.

H. J. ARNIKAR, Banaras.

The above phenomenon has been observed, for the first time in this field of work, in selenium-selenium vapour interface. A Siemens' ozoniser fitted with a side tube containing a sample of purified selenium (red amorphous) was energised by fields due to 50, 100, and 500 cycles per second. An appreciable negative *Joshi-effect* ($-\Delta i$) was observed in all the cases, sensibly above the threshold potential, where it is a maximum, as also its relative value, (*viz.*, $\%\Delta i=100\ i/i_D$, where i_D is the current in the dark at a given applied voltage V). $-\Delta i$ decreased but little, by increasing V from 1.63 to 6.25 *k*V (50 cycles) ; the relative effect, $\%\Delta i$, however, decreased rapidly from 50 to 22% for the same voltage range. The influence of increasing the supply frequency was to diminish $\%\Delta i$ *e.g.*, from 67 to 50% for a frequency change from 50 to 500 cycles per second.

Duration of ageing the system under the discharge had a marked effect on the magnitude of the phenomenon : Whilst $-\Delta i$ set in with but negligible ageing required for its production, its prolonged continuation even at the optimum exciting potential had a suppressant effect. It was remarkable, however, to observe that by nearly allowing the system to rest, the effect was restored, the more completely the longer the rest period.

The production of the negative *Joshi-effect* in selenium is significant in view of its well known photoconductivity.

15. The *Joshi-Effect* and the Phenomenon of Corona Pressure in Air.

H. J. ARNIKAR, Banaras.

The corona pressure, *viz.*, an instantaneous and reversible pressure rise occurring with the application of the field was shown by Joshi to be as high as a few cm Hg in the case of an ozoniser discharge. (*Malaviya Commemoration Volume*, 1932, *pp.* 807-821). The observation by the writer (*Proc. Ind. Sci. Cong.*, 1941, *Phys. Sec.*, Abst. No. 9) (i) of *synchronism between the gas pressure and temperature* throughout the period of several hours of discharge at constant voltage and under steady rate of electrode cooling (effected by circulating ice-cooled water around both the L.T. and H.T. electrodes) and, (ii) of a *complete coincidence in the observed and calculated equilibrium pressures*, indicate that the entire pressure rise is compatible with the temperature rise of the gas under discharge. The extreme rapidity of its occurrence, which distinguishes the corona pressure phenomenon from the pressure rise occurring when the same wattage is dissipated in the gas by, say, a heating coil, is attributed by Tyndall (*Phil. Mag.*, 1918, *35*, 261) to the rapid distribution of the heat produced throughout the gas by the *ionic wind* arising from the oriented motion of the fast ions between the electrode surfaces. This view is consistent with our finding that the corona pressure occurs only at voltages well above V_m, the minimum required to initiate ionisation by collision.

That part of the pressure rise due to ionisation, which Tyndall (*loc. cit.*) had shown cannot exceed 0.5% of the total pressure rise, is given by $p=i/4\pi k$, where p is the pressure rise, i the current per cm. length of the electrode, and k the specific ionic velocity. This component of the pressure rise being a function of discharge current, can be expected to be sensitive to irradiation by light, as i is affected by the *Joshi-effect* during such irradiation. A careful search for a change in the corona pressure in air, employing a reading microscope with an eye-piece scale reading 1/15 mm, did not reveal any such change, as the conditions in respect of gas pressure, voltage, and A.C. frequency of the exciting field, for the occurrence of the *Joshi-Effect* and corona pressure were different. This indicated anti-correspondence between the two phenomena. Thus, in air, measurable corona pressure of the order of 0.1 mm Hg set in only at a minimum pressure of about 12 mm Hg, and at an exciting potential of 3.0 *k*V (500 cycles), or 7.5 *k*V (50 cycles); whereas the *Joshi-effect* had diminished to a negligibly small value at a lower pressure and much feebler exciting field. In other gases, however, it may be possible to locate a common range of conditions where both the effects are measurable.

16. On the Disparity in the Times for Current Suppression and Restoration in the Production of *Joshi-Effect*.

H. J. ARNIKAR *and* S. R. VISVANATHAN, Banaras.

Professor Joshi had observed (*Curr. Sci.*, Oct. 1944, *13*, 253-54) using a cathode ray oscillograph that the time lag in the production of the above phenomenon $-\Delta i$, in Siemens' or wire-in-cylinder type ozonisers, lies within limits of visual persistence. During subsequent work (unpublished results) Prof. Joshi observed that the time for the restoration of i_L, the current under irradiation to i_D, the original value in dark, was sensibly greater than that for the photo-suppression of current, $-\Delta i$. It was of interest to investigate the generality of the above finding. The results now reported refer to the ratio T_r/T_s, time T_r for the restoration (when light is screened off) of the photo-current i_L to that in dark i_D and T_s, the time for the suppression of i_D to i_L. This quantity has been measured in the production of the *Joshi-effect* $-\Delta i$, in chlorine, bromine and mercury vapour, when excited by potentials varied in the range 1-6 kilo volts (r.m.s.) of 50 and 500 cycles supply frequency, at room temperatures and with bromine from 29° to 50°C. A remarkable parallelism has been observed between the values for the ratio T_r/T_s with the corresponding magnitude of the *Joshi-effect*. All the factors *e.g.*, large rise in exciting potential, of the supply frequency and of the temperature of the system, which (numerically) reduce $-\%\Delta i$, bring the above ratio near equality. The results are in general accord with Prof. Joshi's theory of the phenomenon based on the photo-electric emission from a boundary layer formed in part by an adsorption of ions and excited molecules produced under the discharge. (*Curr. Sci.*, 1947, *16*, 19-21; and, *Proc. Indian Sci. Cong.*, 1946, *Phys. Sec.*, Abst. 25)

17. On the Production of *Joshi-Effect* in Sulphur Vapour.

P. DAS GUPTA, Banaras.

Joshi effect in *pure* sulphur vapour was observed almost immediately without any long period of '*ageing*' under the discharge being necessary. At the 'threshold potential' the relative *Joshi effect* ($\%\Delta i$) was about 60% which declined steeply on increase of V, the applied potential. The $\%\Delta i$ decreased in the following order: blue, green, red. Under X-rays $\%\Delta i$ obtained was 10; under ultra violet it was about 80. In the range 30° to 55°C $\%\Delta i$ increased from 60 to 70 and diminished thereafter to about 40 at 70°C. The discharge current in dark (i_D) and in light (i_L), however, increased steadily with temperature.

It was observed that mercury vapour exerted a markedly inhibitive influence on the production of the *Joshi effect* in sulphur, presumably due to the formation, under the discharge, of HgS. A much longer period of 'ageing' under the discharge (about 6 hours) was necessary to obtain Joshi effect in sulphur vapour in the presence of mercury vapour.

18. Inhibitive Influence of Serial Resistance on *Joshi-Effect* in Sulphur.

P. DAS GUPTA, Banaras.

The effect of resistive coupling on the production of *Joshi-Effect* is inhibitive. This is due to the increase of 'damping constant' in the oscillatory circuit. It is in agreement with Joshi's results that H.F. constitute the chief seat of the phenomenon.

Influence of resistive coupling on *Joshi-Effect* in sulphur vapour was investigated. Phenomenon was observed only at R=100 Ω or less. The maximum relative *Joshi-Effect* ($\%\Delta i$) obtained with R=100 Ω was about 15%. Result at greater R showed larger i but no effect was observed. In agreement with previous result of Joshi the $\%\Delta i$ in i_{aerial} in sulphur vapour was found to be markedly greater than in the total current i_{LT}. The 'threshold potential' V_m was found to be indepedent of frequency regions; $\%\Delta i$ at V_m was maximum in both cases. On increase of V $\%\Delta i$ decreased, *e.g.*, at V_m =0.7*kV* $\%\Delta i$ in i_{aerial} and $i_{L \cdot T}$: were 62 and 51; at V=0.8kV $\%\Delta i$ were 24 and 11 respectively. This is attributed to the corresponding preponderence of $i_{L \cdot F}$: which is least affected in the production of the phenomenon.

19. Comparative Study of Hysteresis and the *Joshi-Effect* in Discharge in Chlorine, Bromine, Iodine and Oxygen.

G. S. Deshmukh *and* P. K. Sharma, Banaras.

Results are given for the variation of the conductivity i and the *Joshi-Effect* Δi with the rising and falling applied potential V in homogeneous discharge in Cl_2, Br_2, I_2 and O_2. Four Siemens' type (glass) ozonisers A, B, C and D filled with purified chlorine bromine, iodine and oxygen respectively were excited at the 'threshold potential' V_m of50 and 500 cycles frequency. The exciting potential was then increased progressively to a maximum and reduced to the initial minimum. The current indicator was a reflection galvanometer actuated by a 83 V double diode. During the reversal of V, i and Δi were found to be greater for the decreasing field than that observed during its progressive increase. Hysteresis was more pronounced in i_D than in i_L and was maximum near V_M. As judged by the variation of i and Δi at V_m, the magnitude of hysteresis decrease in the order $Cl_2 > Br_2 > I_2 > 0_2$· Whilst Δi was larger at 50 than at 500 cycles frequency, hysteresis varied in the opposite manner. In excited oxygen, hysteresis was comparatively more pronounced in a semi-ozoniser than that observed in a full ozoniser and especially when instead of platinum a silver wire was used as the central H.T. electrode. The reversal of polarity increased i and Δi; hysteresis was, however, not affected sensibly. Whereas, 'ageing' increased the magnitude of Δi, that of hysteresis was affected adversely. In excited iodine hysteresis was abolished with but a negligible 'ageing' of the system.

20. Influence of Earthing an Axial Metal Wire in the Discharge Space on *Joshi-Effect* in Chlorine,

D. P. Jatar, Saugor.

The influence of earthing a metallic wire along the axis of a discharge tube excited by side sleeves was studied on *Joshi-Effect* in Chlorine. It is found that on earthing the axial wire the discharge current i and the *net Joshi-effect*, Δi, measured in the L.T. line, fall appreciably. The relative *Joshi-effect* $\%\Delta i$, however increases near the threshold potential V_m, and is less for higher voltages on earthing the axial wire directly. When it is earthed through an ohmic resistance, i further falls to a very slight extent as also $\%\Delta i$. The magnitude of $\%\Delta i$ in case of earthing through a resistance is higher than that when it is left floating. Introduction of a bypass condenser in parallel with the resistance is found to restore, nearly completely, the suppression due to the ohmic resistance.

An attempt has been made to explain these results on the "activated layer postulate" and the preferential damping of the high frequency components of the discharge current by ohmic resistance as suggested by Prof. Joshi.

21. Influence of a Serial Resistance and a Bypass Condenser in the Low Tension Line on *Joshi-Effect* in Chlorine.

D. P. Jatar, Saugor.

Earlier results (Joshi–*Pro. Ind. Acad. Sci.*, Vol. XXII, 1945,225) show a suppression of the discharge current i, the net *Joshi-effect*, Δi, and the *relative Joshi-effect*, $\%\Delta i$, by a high resistive impedance introduced in the circuit. The results now obtained show that the above reduction is restored on introducing a condenser bypassing the resistive impedance. A discharge tube filled with chlorine was excited by side sleeves. An ohmic resistance from 0.25 M to 1.0 M was introduced between the L.T. sleeve and the earth. In accordance with earlier results (*ibid*) i, Δi, & % Δi were found to decrease appreciably, the reduction being greater for higher resistance, more pronounced near the threshold potential, V_m. This effect was restored, practically completely, by introducing in parallel with the ohmic resistance a bypass condenser ranging from 0.02 μf to 0.0002 μf; the restoration being more complete near V_m. The above results have been interpreted on the preferential damping of the high frequency components of the discharge current as suggested by Joshi.

22. Production of *Positive Joshi-Effect* in Chlorine under Electrical discharge.

B. B. PRASAD, Banaras.

It has been shown by the author that the above phenomenon *viz.*, $+\Delta i$, a photo-increase of the conductivity, i under discharge, is associated with the L.F. component of i (communicated). The present work was undertaken to study the effect Δi in various other frequencies. A chlorine ozoniser was excited in the range 4-10kV; the discharge current was measured in a triode coupled resistively with the L.T.line. The whole of the apparatus was shielded by means of an earthed metallic enclosure. It was found that the $+\Delta i$ was as high as 400 percent. By eliminating successively higher frequency currents (which is a source of $-\Delta i$), *positive effect* $+\Delta i$ was found to increase. In the D. C. component, which arises out of the asymmetry of the system, only $-\Delta i$ of 26% was found. The very high frequencies showed, however, an enhanced $+\Delta i$. That the positive as well as negative *Joshi-effect* occur together and that an equilibrium exists between the two (*i.e.*, $+\Delta i = -\Delta i$) have been concluded.

23. Influence of Space Charge in the Detection of *Joshi-Effect.*

B. B. PRASAD *and* D. P. JATAR, Banaras.

That the above phenomenon *viz.*, Δi originates chiefly from the H.F. component of the discharge current i and that it is due to the formation of negative ions has been shown by Joshi (*Proc. Ind. Sci. Cong.*, 1946, *Phys. Sec.* Abst, 26; *Curr. Sci.*, 1945 *14*,67). The present work is intended to study the variation due to (electronic) space charge, and the modulation of the frequency thereby in the detector circuit, of the effect Δi. The discharge current (total L.T.) was allowed to flow through a Bell transformer, the latter being coupled to a diode T30 (RCA). The space charge in the detector was controlled by adjusting the filament temperature. At a given applied potential, kV an increase in the space charge initially decreases the effect Δi upto a certain limit after which it increases. Observations of Δi with other diodes, 6H6 and 80 on the other hand show always an increase of *Joshi-effect* %Δi tending to saturation. This last is more pronounced at higher kV besides the current i decreasing near saturation. Thus for *e.g.*, in 80 (RCA) and at 5.34 kV applied potential i decreases from 4.5 to 1.2 when the corresponding Δi increases from 66.6 to 66.8 only. Based on the variation of inter-electrode capacity due to change in space charge an explanation for the above results has been developed.

24. Influence of 'Ageing' on *Joshi-Effect* in Bromine Vapour under Electrical Discharge.

B. B. PRASAD *and* D. P. JATAR, Banaras.

The formation of an 'electrode layer' on the annular walls of a Siemens' ozoniser conveniently adopted for discharge reactions has been postulated by Joshi to be a primary condition for the production of the above phenomenon *viz.*, Δi (Joshi, *Proc. Ind. Sci. Cong.*, 1946.*Phys. Sec.* Abst. 26). The present work is an attempt at the elucidation of the extent of its variability in a Bromine filled glass ozoniser. A freshly prepared tube was exposed to electrical discharge due to 50 cycle A.C. till a stationary state characterised by constant conductivity and Δi was reached. This systen showed a markedly low Δi when it was re-excited after two years of rest. Now restoration of Δi to its previous value took about 400 hours of long 'ageing'. It has been observed further that intermittent 'ageing' at low potentials (above the threshold V_m) is more effective in bringing the final state. The whole 'ageing' is found to be completed in several consecutive stages. A reversible reaction occurring between the glass and the gas has been concluded which is further supported by an increase in Δi due to a moderate rise in temperature. A possible means for studying reactions of this type merely by measuring the effect Δi has been suggested.

25. Production of a Potential-reversible *Positive-Negative Joshi-Effect* in Cl_2 under Semi-ozoniser Excitation.

B. B. PRASAD *and* S. SWAMINATHAN, Banaras.

Investigations using a semi-ozoniser with Ag-electrode coated with AgCl were carried out at potentials varying from 1-6*k*V of 50 cycle frequency. Only *Negative Joshi-Effect* $-\Delta i$ (*i.e.*, photo-diminution of current) of 93.5% occurs at the lower potential and almost exclusively *Positive-Effect* $+\Delta i$(*i.e.*, current increased by light) to an extent of 60% occurs at the higher potential.

At 1.34 *k* V the magnitude of *Negative-Joshi-Effect* $-\Delta i$ decreased progressively from 93.5% to 75.3% with decreasing intensity of white light. The dependence of *Joshi-Effect* on frequency was investigated by carrying out experiments with unfiltered white (7800-3700 Å) and filtered blue (4900-4200 Å), green (5300-4900 Å) and red (5900-5300Å) light. The magnitude of $-\Delta i$ varied frequency wise *i.e.*, white (93.5%)> blue (88.3%) green (64.9%)> red (50%) these values being obtained at the maximum intensity. Invariably a Fatigue-value (*i.e.* $-\Delta i$ was insensitive to variations in light intensities) was observed at low intensities.

At 5.34 *k*V the *positive-effect* increased with decrease of intensity, rises to a maximum and decreases slightly in white and increasingly rapidly in blue, green, and red. The *positive-effect* was found to vary between 17.5 and 29.7, 23.6 and 10.5, 26.2 and 6.1, and 30.6 and0.5 respectively with white, blue, green and red with intermediate maximum values of 36.7, 33.2, 32.7, and 32.3 respectively. In L.T. and L.F. the *positive effect* at the lowest intensity in the three spectral regions continues to be positive while in H.F. reversal to the *negative Joshi-Effect* occurs in blue, green and red at low intensities.

26. Studies on *Joshi-Effect* in Bromine: Influence of Light Intensity and Frequency in H.F. and L.F. Components of the Discharge Current.

B. B. PRASAD *and* M. C. JAIN, Banaras.

That the above phenomenon, *viz.*, Δi, originates primarily in H.F. part of the discharge current, $i_{H.F.}$ and that it is markedly susceptible to factors like intensity and frequency of irradiation, have been shown by Joshi. The present work was intended to study the influence of these factors on Δi, in $i_{H.F.}$ and $i_{L.F.}$ The total low tension current, $i_{L.T.}$, (or its H.F., L.F. parts separated by appropriate inducto-capacitative filters) was allowed to flow through a Bell transformer. the latter being coupled to the detector double diode 6H6 (RCA). Intensity of light was varied by changing the distance of the source from the ozoniser and lights of different frequency bands were obtained by using coloured glass strips; the latters' relative intensities were measured by means of a photo-meter.

The relation suggested by Joshi and Laxminarayaniah, *i.e.*, $\% \ \Delta i = aI^b$ for $i_{L.T.}$ was found to be applicable to $i_{H.F.}$ and $i_{L.F}$ also and with all the frequency filters, but only at low intensities. At higher intensities, however, this initial proportionality between log $\%\Delta i$ and log I as also between $\% \ \Delta i$ and I breaks down, and log $\%\Delta i$ or $\%i$, as the case may be, tends to saturation; for the latter an explanation based on the formation of a charged surface layer on the walls of the ozoniser is developped. Irrespective of the current component measured, the effect Δi was found to increase in the order of the mean frequencies of irradiation, *viz.*, red<green<blue<white, although their intensities were 1.1, 1.6, 1.0 2.0, *i.e.*, in a different order. The sum of Δi in blue, green and red was found to be greater than that in white; this has been attributed to the aforesaid saturation effect.

27. Part III. *Joshi-Effect* in Mercury Vapour under Transverse and Longitudnal Irradiation.

B. N. Prasad, Banaras.

Suggested by the observations of Deo (D.Sc. Thesis, 1947, B.H.U.) and Prasad (*Proc. Indian Sci. Cong.*, 1947, Part III. Phys. Sec., Abst. No. 35) on the influence on Δi in chlorine of the direction of irradiation, a series of observations was made in which Δi in mercury vapour was investigated with irradiation (*a*) tranverse to the ozoniser axis and (*b*) parallel to the axis. It is significant that while the percentage photo-diminution in current under transverse ($\%\Delta i_T$) and longitudual ($\%\Delta i_L$) irradiation differed appreciably (60 and 40 respectively at 0.54*k*V), the corresponding ratio $\%\Delta i_T/\%\Delta i_L$ is approximately constant at 1.5 over the entire range of exciting electrical pressure (0.27 to 1.89*k*V).

28. Part I. Production of the *Joshi-Effect* in Mercury Vapour.

B. N. Prasad, Banaras.

The above phenomenon, a photo-diminution Δi of the discharge current i, has been observed to be pronounced chiefly in halogens; this is attributed by Prof. Joshi (*Curr. Sci.*, 1947, *16*, 19) to the *electron affinity* of the gas. Joshi has argued that the effect Δi should occur in metallic vapours, whose electron affinity is enhanced by excitation under electrical discharge. This prediction, confirmed strikingly by Joshi's results on metallic and other vapours (*ibid.*, *Presi. Address*, *Chem. Sec.*, *Indian Sci. Cong.*, 1943) suggested the present investigation with mercury vapour.

The experimental arrangement consisted essentially of Siemens' ozoniser excited by a transformer discharge. In agreement with Joshi's results, Δi was appreciable only above the 'threshold potential' V_m; this was 0.4 and 0.27 *k*V respectively at 50 and 500 cycle frequency of the A.C. supply. In one typical series of observations, the relative *Joshi-Effect* $\%\Delta i = 100\Delta i/i$ Dark was 36.5 at 2.7 *k*V; As the potential was decreased, $\%\Delta i$ rose progressively to a maximum of 71 at 0.54 *k*V, *i.e.* near V_m, as generalised by Joshi. The influence of an increase of the supply frequency is to reduce $\%\Delta i$, *e.g.*, from 69 to 27.5 at 1.1 *k*V by changing from 50 to 500 cycles.

The influence of '*ageing*' under electrical discharge of mercury vapour was remarkably similar to that of bromine (Deshmukh and Sirsikar, *Proc. National Institute Sci.*, *14*, 157) at a constant potential with 50 cycle frequency, it showed within a moderate period a marked diminution in its electrical conductivity; this reached finally a stationary minimum. Sessation of the discharge for a *short* interval, followed by re-excitation at the original potential, restored the conductivity to the previous value, the more completely the longer the interval. The time of exposure to the discharge for producing the minimum steady conductivity; as also the rest period necessary for restoring i to that at the original potential were greater, the higher the exciting potential. Furthermore, the effect of '*ageing*' was to reduce Δi. At 50 cycle frequency and a constant *k*V an increase in temperature increased the conductivity; the corresponding Δi and $\%\Delta i$, however, decreased.

In general, Δi and the corresponding $\%\Delta i$ increased on increasing the relative intensity of light. Thus for *e.g.*, as this last was increased 256 times in a series of observations at 1.3*k*V, the corresponding Δi and $\%\Delta i$ increased 16 times and tended to saturation for large intensities. *Ceteris paribus*, Δi, decreases in the following order: Light of mercury arc lamp > unfiltered white > filtered blue > green > red light.

29. Part II. Production of *Joshi-Effect* in Mercury Vapour with line sources of irradiation.

B. N. Prasad, Banaras.

By using appropriate filters the two prominent lines *viz.*, 4358Å (blue) and 5461Å (green), from a mercury arc run at 220 volts and 2.5 amperes were used. Their relative intensities, I were respectively 6 and 5; these were far lower than those of the filtered blue and green bands employed earlier. The effect Δi was observed in the ozoniser (*cf.* Part I), excited from 0.54 to 2.70 *k*V, keeping the above light source, 40 cm distant from the ozoniser axis. It is significant to note that the constancy of the ratio, $\%\Delta i$ blue/$\%\Delta i$ green$=$(I blue/I green)$\times$(νblue/νgreen)$=1.5$, at the various applied *k*V used. This shows that Δi can be specified as a function of the significant frequency and its intensity, especially at *low* values of the latter. At a constant *k*V, as I was increased nine-fold, $\%\Delta i$ also increased practically proportionately. According to Joshi's theory of the effect Δi, the primary change leading to Δi, is the photo-eletric emission from the boundary layer formed under electrical discharge on the walls of the ozoniser; its magnitude depending upon the corresponding light intensity. The resultant change in i, however, is determined by secondary reactions, especially of the collision type. These cause saturation in the effect Δi (Joshi, *Curr. Sci.*, 1945, *14*, 39). This inhibitive influence due to secondary reactions should be comparatively low at small pressures of the excited vapour, as in the present work. The observed linear dependence of Δi in mercury vapour on the corresponding light intensity at *low* values, is, therefore, to be anticipated.

30. *Joshi-Effect* in Mercury Vapour : Influence of Ageing.

B. N. PRASAD *and* V. VENKATESWARLU, Banaras.

The profound influence of ageing under electrical discharge on the magnitude of the corresponding *Joshi-Effect* was emphasised by Professor Joshi soon after the discovery of this effect. The above factor has been studied in excited mercury vapour which, remarkably enough, shows practically a 100% *Joshi-Effect* under favourable conditions. Three ozonisers A, B, and C were taken charged with mercury vapour at 0.02 mm pressure, A and B containing traces of liquid mercury besides the vapour and C contained only the vapour. Experimental arrangements were made to obtain a nonstop electrical discharge in the ozonisers for any length of time required. The ozoniser A was kept at a temperature of about 200°C for four hours and then cooled. The ozonisers were simultaneously subjected for 424 hours to a constant A.C. excitation potential (50 cycles) of 0.67 *k*V (r.m.s.). The low tesion current was observed at every 12 and some times 6 hours when the ozonisers were in dark and irradiated by 200 watt 220 volt electric bulb. The detector was a T.30 valve coupled inductively with the low tension and used as a double diode by short circuiting the grid and the plate. In ozoniser A the *Joshi-Effect* was observed after 25 hours and thereafter the magnitude of the relative *Joshi-Effect* fluctuated between 57% and 13% and became constant (60%) at the end of the experiment. These fluctuations were due to variations in the current in dark and under light. In the other two ozonisers the *Joshi-Effect* was never observed showing that a preliminary heat treatment might be necessary for the production of the phenomenon. These results of ageing and its influence on relative *Joshi-Effect* are in general support of the activated layer mechanism posutaled by Prof. Joshi.

31. Influence of Light-Frequency and Light-Intensity on *Joshi Effect* in Iodine Vapour.

M. V. RAMANAMURTI, Banaras.

The dependance of the above factors on the *Joshi effect*, Δi in iodine vapour was investigated in the range of potential V, 200 to 1100 volts (r.m.s) of 50 cycles frequency; with blue, green and red light filters and under relative light intensities I, 1 to 1000.

Δi is +ve at low V, near V_m; and −ve at large V. At a given V, Δi and $\%\Delta i$ (+or−) decrease numerically frequencywise *viz.*, white> blue> green> red. Thus *e.g.*, Δi and $\%\Delta i$ are at 290 V, +43, +860% (white); +35, +700% (blue); +33, +660% (green); +25, +500% (red); and at 400 V, −168, −51% (white); −134, −41% (blue); −70, −21% (green) and −35, −11% (red) respectively. + and−Δi are most pronounced under blue and maximum under white; in green and red very small and at larger V, negligible. At a constant V, within a limited range, *viz.*, 300-525 V, Δi (+or−) white $<\Sigma\Delta i$ (+ or −) under various spectral regions; attributed to a saturation-like effect; Δi (+ or −) follows a linear relationship with the wave number, ν_0 corresponding to the effective mean frequency of the filtered region.

+ and −Δi increased with I, more rapidly at small, than at large I; tending to a saturation at the latter. In a limited range of I, Joshi-Lakshminarayaniah equation $\Delta i = a\,I^b$ where a and b are constants, was found applicable for −and+ Δi also, and the curves, $\log \Delta i$—$\log I$, tend to be linear in agreement with the above equation.

32. Production of *Joshi Effect* in Geissler Discharges.

D. V. Ramana Rao, Cuttack.

Joshi Effect, Δi, an instantaneous and reversible current change on irradiation has so far been observed with semi- and full ozoniser discharges. Under favourable conditions as large as -92% relative *Joshi Effect* has been obtained. During the present investigation it has been extended to Geissler discharges also.

The simultaneous sparking between two ring electrodes kept at the bottom in the annular space of the ozoniser separated by .5 mm. produced a marked variation in the discharge current, i_D measured in the ozoniser circuit and in the magnitude of the relative *Joshi Effect*, $-\%\Delta i$, thereof. Thus the values of i_D at 1.6 *k*V with and without the spark are 36.5 and 2.8; the corresponding values of $-\%\Delta i$ being 31 and 86. It is of interest therefore to study the current and the accompanying *Joshi Effect* if any, in the Geissler part of the discharge alone.

Four Siemens' tubes, filled with purified chlorine at 150 mm pressure and containing copper ring electrodes in the annular space were used for the present study. Continuous spark discharge was maintained between the rings by applying D.C. potentials obtained from a point-to-plate rectifier energised by a H.T. Transformer. Measurements of i_D, i_L, Δi and $\%\Delta i$ were made as in the previous cases. *Joshi Effect* has been observed in all the four tubes; the normal negative effect, $-\%\Delta i$ at low voltages rapidly decreases with increase in the exciting potential and tends to become positive at still larger *k*V. Thus for *e.g.*, the values of $\%\Delta i$ at 2.16, 2.7, and 5.4 *k*V are -78, -7 and $+2$ respectively (Tube. 2) An identical behaviour was observed in all the other tubes.

33. Studies on the *Joshi-Effect* in Oxygen: Influence of terminal reversal and the role of high frequencies in its production.

K. S. Sarangapani, V. Subrahmanyan *and* K. S. Visvanathan, Banaras.

That the *Joshi-Effect*, Δi, *i.e.*, the instantaneous and reversible photovariation in the discharge current, i, in ozonizer type of excitation is of surface origin and occurs chiefly in the H.F. component of the current, as generalised by Joshi, is further supported by studies now reported on the influence of terminal reversal in semi-ozonizers (wire-in-glass cylinder type) containing oxygen at a pressure of 150 mm and excited by (i) alternating potentials of 500 cycles per second, and (ii) unsmoothed unidirectional potentials obtained by using a point-to-plate rectifier tube.

In both types of discharge, the *Joshi-Effect* is found to be markedly greater when the normal connections are reversed, *i.e.*, *when the outer glass cylinder is made the high tension electrode and the central wire earthed.* This confirms the influence of the area of excitation as a determinant of the *Effect*, Δi.

Measurements of the relative *Joshi-Effect*, both in the total discharge current and in the L.F. part (the H.F. being filtered off through a by-pass Capacity, or damped by a serial high resistance), give larger values for the *Effect* in the total current than in the L.F. region. This associates Δi with the high frequency component of i. The above feature becomes more pronounced on terminal reversal. Simultaneously, it is also observed that the proportion of $i_{H.F.}$ is greater under *reversed connections*, giving thereby additional evidence that the H.F. constitutes the major seat of Δi.

It is also inferred that increasing the area of the excited surface favours the production of a greater proportion of H.F. and hence larger *Joshi-Effect.*

34. Effect of Electron bombardment on the After-glow of Active nitrogen

V. Subrahmanyan *and* K. S. Sarangapani, Banaras.

A study has been made of the effect of electron bombardment of active nitrogen on the life (duration) and intensity of its after-glow. The apparatus consisted of a discharge tube in which active nitrogen was produced and a spherical observation bulb with a simple thermionic emitter introduced between the two. This last contained a heating filament of nichrome wire coated with BaO and an Al plate fixed opposite to it at a distance of about one cm. A slow stream of pure dry nitrogen at a pressure of

5 — 6 mm was drawn through the discharge tube which was excited by an induction coil with a spark gap in series. The life (in seconds) and the intensity (visual) of the after-glow in the observation bulb were noted. With the thermionic emitter at just dull-red heat and the plate at an appropriate positive potential, thermions were produced which bombarded the active nitrogen passing through the bulb. As a consequence, the intensity of the after-glow, as observed in the last bulb, was found to have decreased markedly while its life was not appreciably affected.

35. Non-dependence of *Joshi-Effect* on Selective Light absorption in Mercury Vapour.

V. VENKATESWARLU, Banaras.

In view of Professor Joshi's suggestion, that the magnitude of *Joshi-Effect* may be independent of selective light absorption, a spectroscopic study of the problem was undertaken in mercury vapour under *optimum* conditions for the production of the phenomenon. Mercury vapour at 0.02 mm of mercury contained in a Siemens' type ozoniser as modified by Joshi was excited by A. C. potentials of 50 and 500 cycles over a range of 0.2 to 0.6 *k*V (r.m.s.). The L.T. current was measured by a sensitive mirror galvanometer actuated by a double diode (6H6 RCA). Observations were made when the ozoniser was irradiated transversely and longitudinally to its axis with a 200 watt 220 volt electric bulb, mercury arc lamp and a hydrogen discharge tube, after securing constant conditions by ageing under electrical discharge. The magnitude of the relative *Joshi-Effect* when irradiated longitudinally was 98%, 93% and 15% with mercury arc lamp, electric bulb and hydrogen discharge tube respectively.

The absorption spectrum of mercury vapour in the normal and in the excited conditions was studied in the visible and in the ultra-violet, employing the electric bulb, mercury arc lamp and hydrogen discharge tube as light sources. No difference could be found between the absorption spectrum of the normal and excited mercury vapour showing that the absorption is not increased by the passage of the discharge. This was ascribed to the low current density of the discharge which was less than one micro ampere/sq. cm and is in agreement with the work of Metcalfe and Venkateshachar (*Proc. Roy. Soc.*, Vol. 100A. *pp.* 149, 1922), and L.A. Turner and K. T. Compton (*Phys. Rev.* Vol. 25, *pp*, 606, 1924). The independence of Δi with selective absorption now observed in mercury vapour is in accord with the results in iodine vapour (to be published shortly) obtained by Dr. K. V. Rao working in this laboratory.

36. The Rate of Atmospheric Ionization and the Air-Earth Current at Poona.

K. S. AGARWALA, New Delhi.

In this paper, the atmospheric-electric data of potential-gradient, electrical conductivity, concentrations of nuclei and small ions and mobilities of the small ions, published in some earlier papers (J. M. Sil, Sil and Agarwala, Agarwala) from the Indian Meteorological Department, have been made use of to determine the rate of ionization and the air-earth current at Poona at 10 hrs. I.S.T. The graphs for the rate of ionization and the negative air-earth current show fair similarity. The average value of the rate of ionization is estimated to be 14.7 ion-pairs/c.c./Sec. and that of the negative air-earth current 3.7×10^{-7} E.S.U. A comparison of the observed values with the computed results according to (i) the linear recombination law and (ii) the square root law for conditions of ionization has also been attempted.

37. On the Gustiness of Wind and Occurrence of Gusts at Vizagapatam.

K. S. AGARWALA, New Delhi.

The paper summarises the results of a study of the gustiness of wind and of the occurrence of gusts at Vizagapatam, based on the analysis of 3 years' records of the Dines Pressure Tube anemograph with its head 56½ feet above ground. Tables showing the diurnal variation of gustiness for the twelve months of the year are given and briefly discussed. Frequencies of the times of occurrence, velocities and directions of the gusts are also given and their chief features are described. A table showing the highest gust recorded in each one of the three years is also included.

38. Mahajan's maximum and minimum Hygrometer.

L. D. MAHAJAN, Patiala.

In continuation of his pervious research work on Hygrometry, and his inventions of Mahajan's Optical Hygrometer, and Mahajan's Humimeter, the author has now invented another new intrument namely the Mahajan's Maximum and Minimum Hygrometer. It is a kind of Hygrometer which records the Maximum percentage humidity as well as the Minimum percentage humidity of the atmosphere for any period.

It is made on the principle of the Mahajan's Humimeter, but has two more balancing rods, one on each side of the rod of the indicator. These additional rods do not have any pans containing the absorbing material but merely thick heads to balance their corresponding pointers on the dial. These pointers are pushed aside by the indicator, when it moves on the dial on either side. They remain wherever they are pushed to and indicate the maximum and minimum percentage humidity on the dial.

The details of its construction, theory and working are given in this paper.

39. The Influence of Weather Conditions on Long Distance Short-Wave Transmission.

N. S. SUBBA RAO *and* Y. V. SOMAYAJULU, Waltair.

Field strengths at Waltair, of signals radiated from Madras, Calcutta and Bombay stations of the A.I.R. on the 41 and 49 metre bands, have been studied over a period of 7 months. The measurements have been made between 7-30 hrs to 9-00 hrs I.S.T. daily. The day to day variations of the received signal strengths are presented, month by month, in the form of graphs and discussed.

The study of these curves shows that:

1. During the wet season there is a definite relationship between the field strengths of the received signals and the percentage humidities in the atmosphere along the path of the wave—a rise or fall in humidity producing a corresponding fall or rise in the received signal strengths.

2. Further, these effects are more pronounced when the percentage humidities are round about 85%.

3. In cases where the humidities are much lower, there appears to be no relation between these two quantities.

This abnormal transmission, especially during wet season, is traced to reflection at low levels, produced by clouds or zones of condensation or by water vapour molecules themselves.

40. Fermi resonance in the spectra of Benzene.

R. K. ASUNDI *and* M. R. PADHYE, Banaras.

The well-known Fermi resonance phenomenon in the Raman spectrum of benzene naturally occurs also in the absorption fluorescence and emission spectra of the molecule. Particularly in the emission spectrum the phenomenon can be traced upto a loading of three more vibrational quanta of the totally symmetrical 992 Cm^{-1} on each of the fundamental Fermi doublets. The effect of anharmonicity on the spacing of these doublets is discussed.

41. On the Luminescence of Diamond.

V. CHANDRASEKHARAN, Bangalore.

Fluorescent diamonds have the remarkable property of storing up energy under ultra violet excitation a portion of which is emitted as phosphorescence. The rest of it is emitted, however, only on heating the diamond or on re-illuminiating it with visible light. The energy of activation produced is very high when ultra-violet containing only radiations below λ 3000 is used for irradiation while the intensity of fluorescence excited is feeble. While the diamond is fluorescing under this ultra-violet, irradiation of the diamond with intense beam of red light causes the sudden release of the large stored up energy. Hence intensity of luminescence of diamond viewed through a complementary filter increases appreciably above the original value and in a second or two comes down again.

42. Rayleigh's condition of resolution and relative intensities of components.

G. B. Deodhar, Allahabad.

The late Lord Rayleigh prescribed the condition of resolution of a double line which is at present universally accepted. In arriving at this condition, Rayleigh assumed that the intensities of the two compontents are perfectly equal. If inequalities in intensities of the two components are taken into account resolution becomes uncertain if Rayleigh's condition is accepted This is shown by plotting curves with intensity ratios 1.2 and 1.4. If the prescribed distance between the principal maxima is doubled this uncertainity vanishes. It is therefore suggested that for the sake of clarity this double distance should be universally taken as the criterion of resolution.

43. Emission Spectrum of Toluene.

M. R. Padhye, Banaras.

The spectrum of toluene excited by a transformer discharge in flowing vapour consists of a continuous band in the body of which a large number of discrete bands are situated. Thirty four of such discrete bands are measured. Most of them are counterparts of absorption bands. But a few have no counterparts in absorption. An analysis of the observed bands is proposed. The continuous band appears to possess a rather sharp short wave limit which coincides with the origin of the diserete band system. It probably represents the excitation of the phenyl radical.

44. *Atomic lines in flame spectra.*

V. Y. Rajopadhye *and* B. K. Vaidya,

The atomic lines observed in flame spectra usually correspond to an excitation energy of about 5 e. volts. Yet some cases are known where even an energy of 6 or 7 volts seems to be available in the ordinary flame sources, such as the Bunsen flame or the spirit lamp flame. These lines mostly occur as transitions of the excited atom to the ground electronic state, and quite many of them are the "Raies Ultimes" of the elements. Since a large number of lines, down to the ultraviolet region near λ 2300 Å, are easily obtained in the flame spectra of the elements, Arsenic, Antimony, Bismuth, tin, iron and copper, a detailed study has been made of the levels involved in the spectra of these elements.

The spectra of Arsenic, Antimony, Bismuth arise out of similar electronic transitions between the doublet and the quartet terms. The number of lines, occuring in the flame-source, increases from Arsenic to Bismuth as more terms occur within the limits of available energy, and as the ionization potential decreases. The highest level excited for antimony is 6.1 volts, Bismuth 6.3 volts and arsenic 6.7 volts above their respective ground levels. Tin also shows a number of lines, arsising out of singlet and triplet terms, the highest level being 5.3 volts. Iron is known to give a rich spectrum of lines, when iron chloride is introduced in the oxy-hydrogen flame but to produce a line spectrum of iron by using a mild flame it is found that a halide salt of iron must be formed in the flame by the interaction of the metal with a halogen compound. Prominent groups of lines are observed in the spectrum near λ λ 3748, 3581, 2756, 2520, 2480Å., and require energies varying between 3 to 5 e. volts.

In the case of copper, there are two lines at λλ 4651 Å, and 4275 Å, which are known to be due to transitions $4_D \rightarrow 4_p$ and $4_D \rightarrow 4_f$. As these transitions involve negative energy levels which require a fairly high energy of excitation their presence in the flame has been explained by Singh (*Current Science* 11, 330, 1942) as due to (1, 0), and (0, 0) bands of CuH molecules, the actual wavelengths of which are λλ 4648 Å. and 4280 Å respectively. Apart from the small discrepancy in the wavelengths, the arguments in favour of the atomic transitions are (i) possibility of excitation of energy by means other than thermal; (ii) greater transition probability between the levels according to the principle laid down by Meggars; (iii) the terms involved belong to a scheme of energy levels arising out of the excitation of the atom with $3d^9\ 4s^2$ configuration. The energy of excitation calculated from the lowest level of this configuration (metastable state) works out to be only 6.3 volts which is obtainable in the flame sources.

45. The Absorption Spectrum of Ammonium Chloride in the near Infra-Red.

K. G. Ramanathan, Bangalore.

The Infra-red absorption spectrum of ammonium chloride has been investigated using crystals of four different thicknesses, in the region of transmission of the quartz prism. Maxima of absorption are observed to be present at 0.95μ, 1.11μ, 1.35μ and 1.63μ. All of these except the last one have been recorded for the first time. Besides, a band at 2.2μ observed earlier by Coblentz, has been resolved into three separate maxima at 2.12μ, 2.26μ and 2.40μ.

46. Band Spectrum of Zinc Iodide Molecule.

C. Ramasastry, Waltair.

The emission band spectrum of diatomic zinc iodide molecule as excited by a H.F. oscillator is found to consist of five discrete band systems and six continua in the wavelength region 6500Å to 1950Å. The vibrational analyses of four of these systems has given a common lower state with the vibrational constants $we'' = 224.5$ cm.$^{-1}$ and $xe''we'' = 0.8$ cm.$^{-1}$. There is also evidence of predissociation in the upper states of two of the analysed band systems.

The existence of Zinc Isotope with mass number 68 is confirmed spectroscopically.

Almost all the electronic levels of the molecule, which are established from experimental results can be derived theoretically from considerations of electronic configurations in the molecule and the energy states of the individual Zinc and Iodine atoms constituting the molecule.

47. Extension of the Asundi bandsystem, $a'^3\Sigma \rightarrow a^3\pi$, of CO.

Satya Narain Garg, Banaras.

In ordinary discharges through CO tubes it is very difficult (rather practically impossible) to photograph any more of the bands of the above system than those observed by Asundi and supplemented by others so far, and which number about twenty. In a tube containing $SnBr_4$ along with CO_2 the author was able to photograph well-developed bands of the system. The newly added bands number thirtynine. The highest *v′* and *v″* levels involved are 27th and 9th respectively.

48. Formation of Complex Compounds of Lead Nitrate and Potassium Nitrate.

P. N. Sharma, M. R. Nayar *and* J. R. Saraf, Lucknow.

Physico-chemical measurements indicate the formation of the complex compound $K_4[Pb(No_3)_6]$ when aq. solutions of $Pb(No_3)_2$ and $4KNo_3$ are mixed together. Raman Spectral evidence is sought to be obtained for the formation of this new compound.

49. A Critical Pressure Effect in Collisions of the Second Kind.

N. R. Tawde, Bombay.

Phenomena of close resonance in collisions of the second kind is often met with in atomic spectra as a result of coincidence of energy levels of colliding partners—atom and atom. When however, energy transfer takes place in an inelastic way between an atom and a molecule, the spectrum of the latter is excited. Swan bands of C_2 were studied in this way by Tawde and Desai in the presence of argon as foreign gas. They obtained a selective behaviour for the bands at a certain pressure among the many that were investigated, but no explanation was offered for the same. An attempt has been made in this paper to explain the behaviour on the basis of Stern-Volmer condition. This enables the estimation of the lifetime of the excited state $3\pi_g$ of the C_2 molecule and to relate the activation and—deactivation with time defect $(\tau - t)$ where τ is the life-time of the excited state and t is the time between successive collisions.

50. The Dissociation Energy of C_2.

N. R. Tawde, Bombay.

There have been many divergent estimates of the dissociation energy of C_2 molecule. The value of 5.5 *e.v.* has been seriously questioned by Herzberg, whose estimate, following the assignment of the high pressure band of C_2 to swan system at $v' = 6(3\pi_g)$ state comes to a lower value, viz. $D(C_2) = 3.6$ *e.v.*. According to Gaydon's contention, however, this value is a very low estimate and he believes that any value below 4 *e.v.* is very unlikely. Attempt has been made in this paper to apply the intensity distribution to obtain a measure of almost the limit of dissociation by a graphical method using observed statistical weights. The value so obtained is $4.2. \pm 0.2$ *e.v.* which, though closely approaching the dissociation energy, may be somewhat a lower limit, thus confirming the view of Gaydon.

51. Abnormal spectral broadening phenomenon in condensed spark under Glycerine.

N. R. Tawde *and* K. Gopalkrishnan, Bombay.

It is found that the under-glycerine spark gives, besides the molecular spectrum of C_2 (Swan), CO (Angstrom), and CH, atomic lines due to H, O and C. They undergo variation in intensity and structure according to the variation in electrical conditions of excitation.

When the investigation was carried out under controlled conditions of electrical excitation, the broadening of H lines was particularly marked, in which there was an abnormal effect for $H\beta$-line. This was studied with different degrees of condensation and voltage across the spark. The observed results have been compared with those of previous workers and discussed in the light of available knowledge of the mechanism.

52. Polarisation of Fluorescence and Lifetime of the Excited States.

N. R. Tawde *and* N. Ramanathan, Bombay.

The measurement of polarisation of fluorescence affords a method of computing the lifetime of excited states. The lifetime has been found not to vary with viscosity or the temperature of the medium. But it varies with the concentration of the dissolved substance. It is to be noted that the general considerations leading to the derivation of lifetime for different conditions of viscosity and temperature do not help us in obtaining the lifetime for different concentrations. The latter are explainable by the application of the principle of quantum-mechanical resonance involving the migration of energy between the excited and unexcited molecules.

53. The study of Carbon Spectra in 50 cycles (uncondensed) Discharge through CO.

N. R. TAWDE *and* M. K. MENON, Bombay.

Excitation factors in the electrical discharge through CO to produce the Swan or Angstrom bands as stated by Pretty, Merton and Johnson and the present authors (*Abst. Ind. Sc. Cong.* 1948) do not give a defined picture of the conditions necessary as regards condensation or pressure. As a result of recent investigations in this laboratory Swan bands have been obtained even in 50 cycles (uncondensed) discharge through CO at high pressures. This needs explanation from the standpoint of excitation by collisions of second kind or by damped electrical oscillations and related to the capacity effect. Attempt has been made to analyse these aspects.

54. Striking Potentials in H.F. Discharge.

N. R. TAWDE *and* G. K. MEHTA, Bombay.

From the results of our study of H.F. discharge in hydrogen and the results of the previous workers on the striking potentials at different pressures, it is possible to interpret the nature of the striking potential curve (V—p), for different pressure regions. At very low pressures of the order of 10μ, it seems that the secondary emission from glass walls need only be considered but at pressure round about 0.5mm of Hg., ionisation by electron impact becomes appreciable. At pressures higher than 0.5mm ionisation by electron impact is mainly operative. The theoretical aspects of the motion of the electron in the h.f. field at different pressures, depending upon the size of the discharge vessel and the frequency of excitation, considered along with the experimental results, allow definite conclusions about the striking mechanism of the h.f. discharge.

55. Relative Effects of Oxygen and Argon on the Nitrogen Band Spectra.

N. R. TAWDE *and* K. S. KORGAOKAR, Bombay.

The greater suppression of nitrogen 1st positive system relative to others in the spectrum of discharge in air has been invariably attributed by some workers like Gaydon to the presence of 20% oxygen constituent of air. On the other hand according to Johnson, and Tawde and Patanker, a trace of inert gas like argon is enough to bring about a large redistribution of intensity. Now among the rare gas constituents of air argon is more predominant (though much less in comparison to oxygen). So we might expect it to cause a change comparable to that of oxygen. Experiments have been in progress in this laboratory to distinguish between the two. From the results it is possible to compare the magitude of the effect of oxygen with that of argon.

56. An Interpretation of Eddington's Fundamental Theory.

BRIJ NATH, Delhi.

Eddington has introduced two concepts of fundamental importance, the observables and the measurables, but as he works mainly with the measurables, he omits to define the other term precisely. The author gives a symbolic definition based on the Theory of Groups and later interprets the symbolism to deduce most of the well estabished principles of modern physics, in particular the following:— The expansion of universe, the end of the world, the concept of entropy, the dual nature of matter and radiation, Dirac's hole theory, the occurrence and the formation of radio-active substances, and Heisenberg's principle of uncertainty.

The author then examines the foundations of the Relativity Theory and the Quantum Theory and shows that the problem of Einstein's static universe can be solved on the basis of either theory and the results can be compared leading to a combination of two theories. Incidentally he deduces that there are two kinds of time and that Lorentz invariance is possible with respect to one of them only, and also that for systems on the atomic scale time flows unevenly or that time has only statistical significance.

In conclusion the author indicates briefly some of the philosophical problems to which the theory can be applied.

57. The Isothermals of Potassium Chloride at High Temperatures.

B. Dayal, Banaras.

An approximate force model $\phi = \frac{\alpha e^2}{r} + 6\, b e^{-r/\rho}$ has been used to evaluate the free energy and the pressure of the potassium chloride lattice for different values of the volume and the temperature. The Raman theory of crystal vibrations has been used to calculate the thermal part of the pressure. This has been done by evaluating $\frac{d \log \nu}{\partial v}$ for the various frequencies and then taking a statistical average of its values. The average of the frequencies has been used to calculate the thermal energy. It is found that the isothermal for 850° K has a minimum which lies very nearly on the axis of the zero pressure. This temperature which marks the position of the instability of the lattice thus comes out to be about 20 percent lower than the melting point. Preliminary calculations show that the difference between the two temperatures will be less marked if a more accurate force model is used for the calculation of the static part of the pressure.

58. Ionic Nature of Alkali Halides in Solid State.

S. K. K. Jatkar *and* (Miss) S. B. Kulkarni, Bangalore.

The ionic character (i) of alkali halides in solid state have been calculated by applying the relationship $V = A \left\{ i \frac{e^2}{r} + (1-i) \sqrt{D(A-A)(B-B)} \right\}$ where U, A, i, D(A—A), D (B—B), r and e are the crystal energy, Madelung constant, ionic character in crystals, covalent bond energies, crystal distance and electronic charge respectively. The calculated ionic charaters for solids are 82%, 86%, 86% in the case of NaCl, NaBr, NaI and 85%, 86%, 86% in the case of KCl, KBr, KI and that of CsI is 90%. Ionic character (i) of alkali halides in vapour state is lower than in solid owing to decreased internuclear distance (r), ($i \alpha r^2$). The Born empirical and variable factor n in the equation $U = \frac{Ae^2}{r} \left(1 - \frac{1}{n}\right)$ is actually due to partial covalent character of the bonds in the crystal.

59. A Simple Design Automatic Cloud Chamber.

S. Ranga Iyengar, B. A. Krishnaswami Rao *and* C. K. Sundarachar, Tumkur.

A simple type of continuous working cloud expansion chamber, consisting of a filter pump, which functions both as a compressor and as an evacuator and a conventional Wilson expansion chamber with an interposed "dumb-bell ball valve" system is described. The outfit can be assembled with materials available in any ordinary laboratory. Any desired expansion ratio, to get well defined nuclear radiation or cosmic ray tracks, can be got by suitable adjustment of the input water supply to the aspirator pump, the exit water at the compressor and the volume of the exhaust, into which the compressed air in the Wilson chamber adiabatically expands.

60. Finite Pure Flexure.

B. R. Seth, Delhi.

One of the fundamental results in the theory of elasticity is the Bernoulli-Buler law of pure flexure which says that when a beam is bent by terminal couples the bending moment is proportional to the curvature of the central line. This law is widely used in the theory of flexure of prisms, continuous beams and bending of plates and rods. In the case of plates it is known that, if $2b$ is the thickness of the plate and p the radius of curvature in the plane of bending, then for small values of (b/ρ) the moments of the applied couples M_1, M_2 per unit legth applied to the straight and circular edges are (D/ρ) and $(\eta D/\rho)$, η being Poisson's ratio and D the flexural regidity of the plate. It will, therefore, be of interest to know what form these relations take for finite deflections when (b/ρ) is not small.

If ρ is the curvature of the middle surface, the theory of finite strain gives to the second order of (b/ρ)

$$M_1 = \frac{D}{\rho}\left[1 - \frac{1}{15}(2-6c+c^2)\frac{b^2}{\rho^2}\right]$$

$$M_2 = \frac{-\eta D}{\rho}\left[1 - \frac{1}{60}(13-7c)(1-c)\frac{b^2}{\rho^2}\right]$$

61. Experimental and Theoretical Aspects of the Pendant Drop Method of Surface Tension.

N. R. Tawde *and* K. G. Parvatikar, Bombay.

Wilhelmy's original treatment of the pendant drop has in recent years received new orientation as a result of the work of Andreas, Hauser and Tucker defining precisely the size and shape of the drop. Very recently Fordham has developed the theory of the method by which the measure of shape and size can be obtained very accurately and a table of the values of 1/H as a function S has been drawn up. Improved experimental technique has been set up in this laboratory to obtain a measure of S and 1/H by carrying out linear measurements on the photographed enlarged image of the drop. These enable comparison to be made with Fordham's Table.

62. Construction of a New Combined Vacuum Furnace and Mass Spectrometer for Universal Use.

B. N. Srivastava, *and* V. N. Saharia, Allahabad.

In this paper the design and construction of a new combined vaccum furnace and mass spectrometer has been described in detail. The demountable vacuum graphite furnace already in use in this laboratory has been suitably modified so that the ion being effusing from the graphite furnace and travelling in vacuum passes through a 60° Nier type mass spectrometer. The ion beam is first made uniform through acceleration by a high applied voltage and then traverses a homogeneous wedge-shaped magnetic field produced by an electro-magnet with suitably designed pole pieces. By selecting suitable values for the magnetic field and the acclerating voltage the geometrical condition of magnetic refocussing can be satisfied for a particular divergent ion beam and this beam can be collected by a Faraday cylinder in a certain fixed position. This device thus gives us both resolution and refocussing. The set up can be used to collect any ion in the same Faraday cylinder by adjusting the ion accelerating voltage and (if necessary) the magnetic field. Thus ions of different masses could be separately collected and measured. The apparatus is bound to be of great utility in future ionic and thermionic investigations as it provides a simple universal method of producing separately collecting and measuring ions of all substances.

63. Studies on Band Spectra of Some Molecules.

SATYA NARAIN GARG, M.SC., B.SC. (HONS.), Allahabad.

With the object of obtaining CBr and CI emission bands the author photographed the spectrum of discharge through CH_3Br, CH_2 Br_2 $CHBr_3$, and CH_3I both in the visible and the ultraviolet regions. An attempt to systhesise CBr_4 was also made and uncondensed discharge through its vapour was observed. Spectra of HBr and Br_2 were also photographed.

In HBr a continuum, hitherto unknown was obtained starting from about 2600 Å and gradually fading towards the absorption limit of quartz. In other molecules several continual and discrete bands have been photographed whose measurements and study are in progress. Full data will be reported in due course of time.

64. Spectrum of Discharge through $TiCl_4$ Vapour.

SATYA NARAIN GARG, M.SC., B.SC. (HONS.), Allahabad.

The author photographed the emission spectrum of uncondensed discharge through $TiCl_4$ vapour both in the visible and ultraviolet regions. Several new band systems appear to be present in the spectrum of the discharge through flowing vapour. In the discharge through stagnant vapour at low pressure a continuum has been recorded starting from about 3700 Å and going up to the absorption limit of quartz. The outstanding characteristics of this continuum are its purity (being free from even OH band at 3064 Å) and uniformity of intensity. Analysis of the bands is in progress. A full report will be made in due course of time.

(A solid dissociation product of the discharge through $TiCl_4$ gave a slight coating on the quartz window of the tube. The coating was just perceptible and was practically transparent to visible light, but, absorbed totally all light below about 2800 Å. The chemical identification of the said product will be shortly undertaken.)

65. Magnetic Properties of Cobalt Salts at Low Temperatures.

BHAGAWATI CHARAN GUHA, D.SC., Calcutta.

Measurements have been made on a number of cobalt salts from room temperature down to about 80°K. Though the CO^{++} ion is in the F-state as the Ni^{++}, the Stark pattern for a given field for Co^{++} is inverted with reference to Ni^{++}. As a result of this inversion the lowest level of Stark pattern which is a singlet in Ni^{++}, will now be a triplet. This makes the magnetic behaviour of Co^{++} much more complicated than that of Ni^{++}.

The values of the principal magnetic moments of the cobalt Tutton salts and the general trends of their temperature variations suggest that the rhombic fields in them should be of nearly the same magnitude. An estimate has been made of this field, and it is found that in cobalt sulphate heptahydrate and cobalt selenate hexahydrate the rhombic fields are definitely greater than in Tutton salts.

In the selenate the p^2 value corresponding to the lowest of the three principal susceptibilities falls down so rapidly with decrease of temperature that this susceptibility actually shows a maximum at about 130°K, below which temperature the susceptibility decreases with the lowering of temperature.

66. A note on a simple form of Voltage Stabiliser.

N. K. SAHA, B. S. CHANDRASEKHAR *and* M. K. SUNDARESAN, Delhi.

A simple form of voltage stabiliser for the range 600—2000 volts, suitable for use with G.M.—counters is described. The stabilisation is effected with the help of gas-ionisation in a air discharge tube of variable pressure connected in parallel to the transformer output. At a stabilised voltage of $\sim$1500 a deviation of $\sim$2.5% was observed when the transformer output was varied between 2000 and 3500 Volt. As such a wide variation of the transformer output is not likely to occur in practice, the stabilisation attained is generally very satisfactory. Simplicity of the electrical circuit, ease of operation in changing the range of stabilised voltage, good accuracy and low cost are the main features of the method.

67. Dielectric Dispersion of Polar Solutions.

S. K. K. Jatkar *and* B. R. Y. Iyengar, Bangalore.

An expression has been derived for the dielectric dispersion of polar solutions taking into consideration the individual orientations and relaxation times of the molecules of the polar components. Oncley's semi-empirical relationship which has been applied to solution of proteins is shown to follow from the new equation, after effecting certain valid approximations. It has also been pointed out that the equation used by Collie, Hasted and Ritson to interpret the dispersion of aqueous ionic solutions is erroneous.

68. Dielectric Dispersion of Water.

S. K. K. Jatkar *and* B. R. Y. Iyengar, Bangalore.

The data of recent measurements on the dielectric constants and loss angle of water at different temperatures and frequencies has been used to calculate the critical frequency and molecular radius of water, by applying the new equation for dielectric dispersion of polar liquids. A temperature independent value of 1.4 Å is obtained for the molecular radius in agreement with the accepted value.

69. A New Linear Time Base Circuit.

Miss Lily Mathew *and* N. B. Bhatt, Bangalore.

There are several known methods by which a voltage varying linearly with time may be obtained from the exponential charge or discharge of a condenser through a resistance, some of which are used in the time base circuits of commercial Cathode Ray Oscillographs. While such circuits give sufficient linearity in practice (N. B. Bhatt, Current Science, XIV, 166, 1945) it has been shown by Clarke (Wireless Engineer, XXVI, 256, 1944) that theoretically absolute linearity is unattainable by them. A new type of circuit has been evolved by the Authors which under easily attainable conditions is shown to have a linearity approaching the ideal case. In practical rig-up the circuit takes the form of a constant charging circuit with a thyratron trigger; the exponential voltage output is then introduced into a vacuum tube stage so arranged that its output voltage is truly proportional to the logarithm of the input. Such a logarithmic stage was first described by Meagher and Bentley (R.S.I.,VII, 339,1939) and later investigated by D. L. Subrahmanyam of this Laboratory (Electrotechnics, March, 1948). This is followed by a two stage direct coupled amplifier whose output is finally applied to the horizontal plates of a cathode ray oscillograph. Preliminary results have been very promising in as much as the circuit shows a decided improvement in linearity over that achieved by commercial instruments besides offering certain other advantages. The work so far has been confined to the frequency range of 50-10,000 c.p.s. but its extension on both the low and high frequency sides is under progress. The advantages and the requirements of the circuit are discussed.

70. Influence of the Ozonizer-size on the Joshi Effect in Chlorine.

P. G. Deo, Saugor.

Following the observations of Joshi and coworkers (*Proc. Ind. Sci. Congr.* pt. III, 1941-47) that the walls of the discharge vessel play an important part in the production of the *Joshi Effect*, the influence of the ozonizer-size on the magnitude of the effect has been investigated. Experiments were carried out at Banaras with ozonizers S_1, S_2, S_3, S_4, and S_5, similar in all respects but of effective lengths 19.5, 15.8, 7.9, 3.1 and 1.9 cms. respectively. The results show that the magnitudes of Δi the *Joshi Effect*, are in the order $S_1 > S_2 > S_3 > S_4 > S_5$, *i.e., ceteris paribus*, the magnitude of the phenomenon increases by increasing the exciting surface.

The *wall effect* and other allied phenomena which are of general occurrence in a discharge reaction have been briefly reviewed. Evidence obtained so far shows that the solid-gas interface and its immediate neighbourhood play an important part in the production of this phenomenon.

71. Influence of Intensity of Irradiation on the Joshi Effect in Chlorine.

P. G. DEO, Saugor.

Earlier results employing distance-variation method (Deo, *Ind. J. Phys.*, 1944, *vol.* 18, *p.*84) have shown that the magnitude of the *Joshi Effect* depends markedly on the intensity of irradiation. This has been now studied with an improved technique of intensity variation, *viz.* a nicol-pair, in which the intensity of the transmitted light varies as $\cos^2\alpha$, α, being the inter-nicol angle. The results obtained at Banaras show that the relationship of % Δi, the percentage *Joshi Effect*, (or even Δi since i dark was kept constant) towards α, $\cos\alpha$ and $\cos^2\alpha$ is not linear. The $\%\Delta i$—I (*i.e.* $\%\Delta i-\cos^2\alpha$) curve is found to be concave towards the intensity-axis which appears to be the characteristic of the phenomenon. Over the restricted range it is observed that the variation of the *Joshi Effect* with the incident intensity may be represented by $\% \, \Delta i = a\mathrm{I}^b$. This has been considered from the well known Freundlich isotherm $x = mp^n$ where X, is the amount of the gas absorbed, p is the gas pressure, and m and n are constants. The ratio *Joshi Effect* : light intensity, decreases with the intensity. This has been compared with some heterogeneous photo-reactions which show similar dependence presumably due to saturation.

72. Magnetic Behaviour of Potassium Ferricyanide from Room Temperature to liquid Air temperature.

BHAGAWATI CHARAN GUHA, D.Sc., Calcutta.

The Fe^{+++} ions in potassium ferricyanide crystal is *covalently* co-ordinated with its neighbours. Such a binding will conduce to a much closer approach between the central ion and the surrounding atoms, and hence to a much larger crystalline electric field in the centre than will be the case in the ionic salts.

L. C. Jackson (1933) measured by a different method the principal susceptibilities of the ferricyanide from room temperature to 75°K. Though there is a general agreement between Jackson's values and ours, this does not extend to the details. For example, the $x_1 - x_3$ values rises very sharply, reaches a maximum at about 120°K, and falls equally rapidly on further lowering of temperature. This interesting result has been obtained by us as we measured the anisotropies directly. Our p_s^2 values are practically independent of temperature in the region of 120° to 80°K, whereas Jackson's values come down rapidly with temperature even in this range. Again the numerical values of the principal moments obtained by us are consistently lower than Jackson's. It should be mentioned that both Jackson's values and ours fit well with the theoretical calculations of Howard (1935), based on some reasonable assumptions for the fields over the whole range of our measurements.

36th INDIAN SCIENCE CONGRESS, ALLAHABAD 1949

SECTION OF CHEMISTRY

PRESIDENT : P. B. GANGULY, D.Sc., F.N.I.

Abstracts

Inorganic Chemistry

1. Oxidation Potential and Instability Constant of Ethylenedibiguanide Complex of Tripositive Silver.

PRIYADA RANJAN RAY *and* DEBABRATA SEN, Calcutta.

Oxidation potential of the system, complex silver ethylenedibiguanide nitrate (with tripositive silver) and silver nitrate, has been measured in water and acid solutions at room temperature under different conditions of concentration of the constituents against saturated calomel electrode in a Beckmann pH and potentiometer. From these and the standard oxidation potential of the argentic (III)-argentous (I) system, the instability constant of the complex tripositive silver ion has been determined. The standard oxidation potential of the argentic-argentous system was assumed, after necessary temperature correction, to be more or less equal to the E.M.F. obtained by Luther and Pokorny (*Z. anorg. Chem.*, *57*, 1908, 290) at 25°C. for the system,

$$\text{Pt}, \ Ag_2O_3, \ Ag_2SO_4 \text{ sat.} \quad 0.5 \ \frac{H_2SO_4}{2}, \ H_2,$$

which gave a value of 1.74 volt. Though this assumption was more or less an arbitrary one, nevertheless it presumably shows that the actual value cannot be lower than this. An order of the instability constant of the complex can thus be obtained from the results of the measurements made. The value of this instability constant was found to be of the order of 10^{-28} in water solution and of the order of 10^{-25} in acid solution, showing thereby that the presence of H^+-ions catalytically retards the degree of dissociation of the complex ion and hence lowers the value of the instability constant. This is also supported from a study of the rate of decomposition of the complex ion in water and acid solutions respectively. The dissociation of the complex is followed by a slow decomposition reaction, which is superimposed upon the former and is practically irreversible under the condition of the experiments. The reactions that occur, are shown below :

$$[Ag\ Et(BigH)_2]^{3+} + 2H^+ \longleftrightarrow Ag^{3+} + Et(BigH_2)_2^{++}$$

$$A^{3+} + H_2O \longrightarrow Ag^+ + H_2 + 1/2\ O_2$$

The value of the instability constant, K, for the complex may be compared to that of the cobaltammine complexes and that of cobaltous tertrammine and cadmium tetrammine studied by Lamb and Larson (*J. Amer. Chem. Soc.*, *42*, 1920, 2024), and which are of the order of 10^{-34} , 10^{-5} and 10^{-7} respectively. This leads to the conclusion that the quadri-covalent silver ethylenedibiguanide nitrate is a quite stable complex yielding in its molar solution an argentic (Ag^{3+}) ion concentration of the order of 10^{-15}.

$Et(BigH)_2$ = one molecule of ethylenedibiguanide $= C_6H_{16}N_{10}$.

2. The Magnetic Study of Cadmium Salts.

MATA PRASAD, S. S. DHARMATTI *and* R. A BHOBE, Bombay.

The magnetic susceptibilities of Cadmium salts of organic and inorganic acids prepared in a chemically pure state, have been measured on a modified form of Gouy's balance. From the mass susceptibilities thus obtained, the ionic susceptibility of Cd^{++} has been determined by the method of averages utilising the various values of anions given by different authors, and has been compared with the theoretical values. It is observed that the ionic susceptibility of Cd^{++} deduced from the salts of organic acids is higher than that derived from the salts of inorganic acids. The magnetic behaviour of cadmium salts has been compared with the behaviour of those of its family elements, Mg^{++}, Zn^{++}, & Hg^{++}. It has been found that the graphs of the molar susceptibilities of the salts of Mg, Zn, Cd & Hg against the number of electrons in the molecule are strikingly similar in nature. A linear relation has been obtained by plotting graphs between the molar susceptibilities of salts of Mg, Zn, Cd & Hg containing the same anion, and the number of electrons in the cations Mg^{++}, Zn^{++}, Cd^{++} & Hg^{++}. This linear relation has been employed to deduce the ionic susceptibility of Cd^{++} ion in inorganic and organic salts. The ionic radius of Cd^{++} has been calculated from the magnetic data and compared with the values given in the literature.

3. The Diamagnetic susceptibilities of Silver Salts.

MATA PRASAD, S.S. DHARMATTI *and* M. G. DATAR, Bombay.

Some silver salts of organic and inorganic acids have been prepared in a chemically pure state and their magnetic susceptibilities have been measured. The experimental value of the ionic susceptibility of silver has been determined from the mass susceptibilities of those compounds by the usual statistical method. A comparison of this value with the theoretical values calculated according to Slater's and Angus' methods shows that the experimental value is lower than the theoretical values. The experimental value of the ionic susceptibility of silver derived from organic salts is higher than the one derived from inorganic salts. The magnetic behaviour of some of the silver salts has been examined along with that of cuprous salts. It has been found that the graphs of mass susceptibilities against the total number of electrons in the compounds of silver and cuprous salts are strikingly similar in nature. The ionic radius of silver has been calculated from the magnetic data and is found to be slightly greater than the one obtained by Goldschmidt by X-ray method.

4. Ferroelectric Solids, KH_2PO_4; AmH_2PO_4, KH_2AsO_4 and AmH_2AsO_4.

S. K. K. JATKAR *and* S. N. GOPALASWAMY, Bangalore.

The existence of dielectric properties analogous to the magnetic properties of ferromagnetics has been observed in the case of the following substances, KH_2PO_4, AmH_2PO_4, KH_2AsO_4 and AmH_2AsO_4. It has been found necessary to postulate a critical temperature θ in order to satisfactorily account for the temperature coefficient of the dielectric constants of this class of substances. With the introduction of this characteristic temperatur ‘. the new equation relating dielectric constants (ε) and dipole moment (μ) becomes, $(\varepsilon-n^2)\frac{M}{d}=\frac{4\pi N\mu^2}{K(T-\theta)}$. From the measurements on the dielectric constants the crystals KH_2PO_4, KH_2AsO_4, AmH_2PO_4 and AmH_2AsO_4 are found to have the transation temperature 115°K, 91°K, 155°K and 220°K respectively. These molecules have a moment of 2.04, 2.03, 2.77 and 2.74 respectively, ammonium ion influencing the moment.

5. The Dielectric Properties of the Complexes of the Halides of Aluminium, Boron and Beryllium.

S. K. K. JATKAR *and* S. N. GOPALASWAMY, Bangalore.

The molar polarization of the halides of aluminium, boron and beryllium has been calculated from the data for their complexes regarding them as forming ternary mixtures and accordingly the new equation was modified :

$$_{123}=(\varepsilon-1)\frac{M_1f_1+M_2f_2+M_3f_3}{d_{123}}=P_1f_1+P_2f_2+P_3f_3$$

The moments calculated for these halides in binary systems have been explained on the basis of the component law assuming that the bonds are free to rotate whereas in the case of ternary systems the organic components of the complexes hinder the free rotation making the halide molecule rigid and the classical vector law holds good. The ionic characters of the bonds have been deduced from the observed and theoretical bond moments.

6. Dielectric Constant of the Oxides BeO, As_2O_3, Sb_2O_3 & Bi_2O_3.

S. K. K. Jatkar *and* S. N. Gopalaswamy, Bangalore.

Beryllium oxide has a dielectric constant of 12.55 at 30°C. as determined by the mixture method. From the data on the index of refraction and density the moment of the molecule is calculated to be 0.66. The effective moment of the Be-O bond is equal to the product of the observed moment and the coordination number. Accordingly the Be-O bond is 33% ionic which is exactly equal to the value $\left(\frac{Z_A}{Z_A+Z_B}\right)$. The dielectric constant of arsenious oxide has been determined by both the mixture method and the temperature method over a range of temperature from 30° to 70°. The oxide has a moment of 0.92. The effective As-O moment is four times this value, 4 being the effective coordination number. Accordingly the As-O bond is about 38% ionic. The values calculated by the new relationship for As-O, Sb-O and Bi-O are respectively 40%, 86% and 91% which are in fair agreement with the experimental values.

7. Dipole Moment of Alkyl and Phenyl Lead Halides.

S. K. K. Jatkar *and* R. J. Sujir, Bangalore.

The new equation has been used to calculate the dipole moments of Triphenyl lead, Trimethyl lead chloride, Thiethyl lead chloride, Diethyl lead dichloride, Triethyl lead bromide, Triphenyl lead chloride, Triphenyl lead bromide and Triphenyl lead iodide. The ionic natures of Pb-Cl, Pb-Br and Pb-I have been calculated and compared with those obtained by the new relationship $\frac{Z_a}{Z_a+Z_b}$. The ionic characters calculated by Lewis *et al* are found to be systematically higher than those calculated by the new equation.

8. Dipole Moments of Certain Compounds of Sulphur, Selenium and Oxygen

S. K. K. Jatkar *and* R. J. Sujir, Bangalore.

The new relationship has been used to calculate the dipole moments of hydrogen disulphide, sulphur mono-chloride, selenium monochloride, selenium oxychloride and thiophosphoryl chloride. The moments calculated by the new equation are independent of concentration unlike the D.C.M. equation. The ionic characters are calculated and checked with theoretical values.

9. On the Volumetric Estimation of Cerium by $KMnO_4$.

G. S. Deshmukh, Banaras.

The present work arose out of the difficulties experienced in the detection and separation of cerium from zirconium and thorium in the qualitative analysis of mixtures containing other common inorganic radicles. The separation of these rare earths from other radicles of the third and subsequent groups is affected by their coprecipitation as oxalates in acidic solutions. Further analysis of the combined oxalates depends on the solubility of thorium and zirconium oxalate in ammonium oxalate solution. Resuts of a series of experiments have shown that cerium oxalate is also partially soluble in ammonium oxalate and therefore, the detection and estimation of cerium is unsatisfactory. A simple process for estimating cerium volumetrically by $KMnO_4$ has been developed by modifying the classical oxalate method used generally to determine cerium gravimetrically as CeO_2. Data are given to show that the results are within the limits of experimental error.

10. Application of the Solubility Method for the Elucidation of the Compositions of some Complex Compounds of Silver—Part I. Study of AgCl-$Na_2S_2O_3$ system.

ARUN K. DEY *and* A. K. BHATTACHARYA, Saugor.

The solubility method of Dey (*Compt. Rend. Acad. Sci.*, U.S.S.R., 1947; *J. Ind. Chem. Soc.*, 1947; *Proc. Ind. Sci. Cong.*, 1948) has now been applied for the study of complex formation between silver chloride and sodium thiosulphate.. The formation of the complex argentothiosulphate may be represented to proceed according to the following equation:

$$n\mathrm{Ag}^{o} + \mathrm{S_2O_3}'' \longleftrightarrow [\mathrm{Ag_nS_2O_3}]^{-(2-n)}$$

The value of n in this case works out to be:

$$= \frac{-\left\{\log\frac{a_1}{a_2} - \log\frac{c_1}{c_2}\right\} \pm \sqrt{\left\{\log\frac{a_1}{a_2} - \log\frac{c_1}{c_2}\right\}^2 - 4\log\frac{a_1}{a_2}\left(\frac{a_1}{c_1} - \frac{a_2}{c_2}\right)}}{2\log(a_1/a_2)}$$

when a_1 and a_2 represent the quantities of silver dissolved in c_1 and c_2 concentrations of thiosulphate solutions respectively, the method of calculations being similar to those described in previous publications.

The solubilities of silver chloride in varying concentrations of sodium thiosulphate solutions have been determined at different temperatures. On calculating the values of n with the help of the expression derived, it is found that the values of n at 15°C varies from about 0.65 to 0.84 with increase in the concentration of thiosulphate. Similarly at 30° n varies from 0.55 to 0.95, while at 40° it does not change so remarkably, remaining almost equal to 0.5 with all the concentrations of sodium thiosulphate used.

It has therefore been concluded that the complex ions have the formulae $[\mathrm{AgS_2O_3}]'$ and $[\mathrm{Ag(S_2O_3)_2}]'''$ and the variations in the values of n correspond to the compositions of mixtures of the monovalent and trivalent complexes, the ratio of which is regulated by the conditions of temperature and concentration.

11. Application of the Solubility Method for the Elucidation of the Compositions of some Complex Compounds of Silver—Part II.. Study of AgBr-$Na_2S_2O_3$ system.

ARUN K. DEY, Saugor.

In continuation with the work on complex argentothiosulphates, the composition of the complex ions formed by the interaction between silver bromide and sodium thiosulphate has been calculated with the help of the expression derived in Part I of the present series of papers.

In this case the vaues of n also change with the change in concentration of thiosulphate and also with temperature. An examination of the experimental results shows that at 30° the value of n changes from 0.37 to 0.51, at 50° from 0.53 to 0.67 and at 75° from 0.74 to 0.94. A perusal of the values of n in this case too suggests the existence of mono- and trivalent complex ions of the compositions $[\mathrm{AgS_2O_3}]'$ and $[\mathrm{Ag(S_2O_3)_2}]'''$. It is interesting to observe that with rise in temperature the chances of the formation of the trivalent complex ion are more prominent in this case.

12. Application of the Solubility Method for the Elucidation of the Compositions of some Complex Compounds of Silver—Part III. Study of Ag_3Cit-Na_3Cit system.

ARUN K. DEY *and* A. K. BHATTACHARYA, Saugor.

During the study of the preparation of some silver hydrosols of silver by the reduction of silver citrate, Ghosh and Chakravarti (Doctoral Thesis, Allahabad, 1945) observed that in the presence of citric acid the solubility of silver citrate was markedly enhanced. They have ascribed this phenomenon to be due to the excess of hydrogen ions in the solution contributed by citric acid. This work has now been extended and we observed that augmented solubility is also observed on using a solution of sodium citrate. Thus, this is evidently a case of complex formation, which view has been further substantiated by actual solubility determinations and utilisation of the data for the calculation of the composition of the comlex ion by a method similar to that described by us in Parts I and II of the present series. (Cf. also Dey, *Compt. Rend. Acad. Sci.*, U.S.S.R.,1947, *J. Ind. Chem. Soc.*, 1947; *Proc. Ind. Sci. Cong.*, 1948).

The complex formation may be represented by the equation :

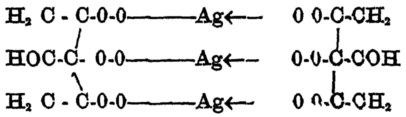
$$nAg_3Cit + Na_3Cit \leftarrow\rightarrow Na_3[Ag_{3n}(Cit)_{n+1}]$$

In this case the value of n when calculated is found to be:

$$= \frac{\log \frac{s-3\sqrt{k/c}}{s'-3\sqrt{k/c'}} - \log c/c'}{\frac{1}{3}\log\left[k\left(\frac{1}{c}-\frac{1}{c'}\right)\right] + \frac{1}{s'-3\sqrt{k/c'}} - \frac{1}{s-3\sqrt{k/c}}}$$

where k is the solubility product constant of silver citrate, and s and s' the solubilities of Ag in sodium citrate solutions of concentrations c and c' respectively.

The experiments were conducted at 30°C, and the values of n worked out to be almost equal to unity in all the cases, with different concentrations of sodium citrate. Thus the complex compound has the formula: Na_3Cit, Ag_3Cit and the following structure has been suggested :



H₂ C - C-0-0——Ag←— 0 0-C-CH₂
HOC-C- 0-0——Ag←— 0-0-C-COH
H₂ C - C-0-0——Ag←— 0 0-C-CH₂

13. Studies on the formation of complex compounds between Alkaline Earth Nitrates and Alkali Nitrates. -Part I. System: $Ba(NO_3)_2$-KNO_3-H_2O.

M. R. Nayar *and* P. A Chauhan, Lucknow.

A double salt of the formula $Ba(NO_3)_2 \cdot 2KNO_3$ has been long known to exist, but somewhat inexplicable results obtained by Fundlay and coworkers (*Journ. Chem. Soc.* 1914, 779.) necessitate detailed systematic investigation of the system $Ba(NO_3)_2-KNO_3-H_2O$. Conductivity of solutions containing varying amounts of barium nitrate (ranging from M/60 to M/3) mixed with constant concentration of potassium nitrate was measured. A sharp kink in the graph was obtained at a point corresponding to the formation of the compound $Ba(NO_3)_2 \cdot 2KNO_3$. This abnormality in the graph can only be explained by assuming that there exists some complex ion besides simple $Ba^{\cdot\cdot}$, $K^{\cdot}$ and NO_3'' ions at that concentration. Further work on the subject is in progress.

14. Studies on the formation of complex compounds between nitrates of Zinc group and Alkali nitrates.—Part I. System : $Zn(NO_3)_2$-KNO_3-H_2O.

M. R. Nayar *and* P. R. Chauhan, Lucknow.

Literature gives no information whatsoever on the formation or otherwise, of the complex compounds between zinc nitrate and potassium nitrate, though complexes between chlorides, bromides, sulphates, nitrites and even citrates and tartarates of the two metals have been described. The application of various physico- chemical properties with a view to find out complex ion formation as followed by Nayar and Pande (*Proc. Ind. Acad. Sci.*, 1948, April and May issues) in the case of lead nitrate and alkali nitrates was extended to zinc nitrate and potassium nitrate in aqueous solutions. The properties chosen for investigation were Viscosity and Conductivity, each depending on factors entirely different from one another, the former being a bulk property and the latter being affected by ions. When values for viscosity and conductivity were plotted against varying concentrations of zinc nitrate (concentration of potassium nitrate being kept constant at M/3), it was found that both the curves thus obtained were smooth without any abnormality, indicating that the tendency for complex formation which is so marked in the case of lead nitrate and potassium nitrate (Nayar and Pande, *loc.cit*), disappears when zinc nitrate is substituted for lead nitrate in the system.

15. Studies on the formation of complex compounds between Nitrates of Zinc group and Alkali Nitrates.—Part II. System: $Hg(NO_3)_2$-KNO_3-H_2O.

M. R. NAYAR *and* P. R. CHAUHAN, Lucknow.

The system: mercuric nitrate - potassium nitrate - water, was next investigated. Viscosity and conductivity were measured as in the case of zinc nitrate and potassium nitrate. The values obtained were plotted against varying concentrations of mercuric nitrate (ranging from M/60 to M/2) - concentration of potassium nitrate being kept constant at M/3. The curves thus obtained were regular without abnormalities, showing that solutions in all ratios of the two salts behave as simple mixtures of mercuric nitrate and potassium nitrate and that there is no tendency for complex formation. Ephraim (*Inorg. Chem.* 1943, 699.) has postulated mercury acting as a central atom to co-ordinate with several nitrate groups, but our work has not given the anticipated results at the concentrations chosen.

Since zinc nitrate and mercuric nitrate yielded similar negative results it was considered unnecessary to investigate the intermediate salt cadmium nitrate.

16. Formation of Complex compounds between Lead Nitrate and Alkali Nitrates.—Part VII. The system: $LiNO_3$-$Pb(NO_3)_2$-H_2O

M. R. NAYAR *and* C. S. PANDE, Lucknow.

In previous communications (*Proc. Ind. Acad. Sci.*, A, 1948, *27*, 284-299 & subsequent issues), it has been shown that three definite complexes are produced in solution in each of the systems: KNO_3–$Pb(NO_3)_2$–H_2O & NH_4NO_3–$Pb(NO_3)_2$–H_2O, while no such formation could be detected in the sustem: $NaNO_3$—$Pb(NO_3)_2$—H_2O. It was of interest to extend the investigations to other alkali nitrates above sodium and below potassium. This paper reports the results obtained with the system: $LiNO_3$—$Pb(NO_3)_2$—H_2O. The properties investigated were viscosity, conductivity and transport number. The methods employed were the same as described before.

When the values of viscosity and conductivity were plotted against the concentration of lead nitrate, smooth curves were obtained without any kinks. All the plots were regular indicating the tendency for the formation of complex compounds to be nil. Transport number values also showed no marked change, leading to the same conclusion.

Thus lithium nitrate like $NaNO_3$ and unlike KNO_3 and NH_4NO_3 has no tendency for the formation of complex compounds with lead nitrate. This was expected from its position in the Periodic Table.

17a. Formation of complex compounds between Lead Nitrate and Alkali Nitrates.—Part VIII (pH measurement).

M. R. NAYAR *and* C. S. PANDE, Lucknow.

In continuation of our investigations described in the preceding parts of this series (*Proc. Ind. Acad. Sci.*, A, 1948, April & May issues), we report our results in this paper on pH measurements by using glass electrode. For pH measuremenrs the glass electrode assembly used was the one described by Nayar & Srivastava (*Curr. Sci.*, April 1947, *16*, 116). The potentiometer was calibrated in the usual way by using standard Weston cadmium cell.

Buffer solutions were prepared having pH values between 2-9 and corresponding E.M.Fs measured. Thus a standard graph (a straight line) was obtained, connecting the pH with E.M.F. The pH of any unknown solution could be read from the graph, if the E.M.F. was known.

The results obtained with the various solutions prepared as described in the earlier parts of this series were represented graphically, *i.e.* pH values plotted against the concentration of lead nitrate. These graphs indicate that there is no complex formation in the system : $LiNO_3-Pb(NO_3)_2-H_2O$, while three definite complexes are present in solution in the systems: $KNO_3-Pb(NO_3)_2-H_2O$ & $NH_4NO_3-Pb(NO_3)_2-H_2O$. The molecular formulae of these compounds are, $4RNO_3.Pb(NO_3)_2$, $2RNO_3.Pb(NO_3)_2$ & $RNO_3.Pb(NO_3)_2$ (where R stands for K or NH_4). Thus the results obtained with pH measurements are exactly in conformity with observations and results obtained from other physico-chemical properties.

17b. Formation of complex Compounds between Lead Nitrate and Alkali Nitrates.—Part IX. The system : $Rb(NO_3)_2$-$Pb(NO_3)_2$-H_2O.

M. R. Nayar *and* C. S. Pande, Lucknow.

In the previous parts of this series we have already shown the existence of three complex compounds in solution in each of the systems : $KNO_3-Pb(NO_3)_2-H_2O$ & $NH_4NO_3-Pb(NO_3)_2-H_2O$, while no such formation was observed in the systems: $LiNO_3-Pb(NO_3)_2-H_2O$ & $NaNO_3-Pb(NO_3)_2-H_2O$. It was of interest to extend the investigations to other alkali nitrates above potassium. In this paper we report our results obtained with the system: $RbNO_3-Pb(NO_3)_2-H_2O$. The properties investigated were viscosity, conductivity and transport number. This system has not been investigated before by any other previous workers.

Physical Chemistry

18. Magnetic Study of Some Hydrates.

Mata Prasad, S. S. Dharamatti, C. R. Kanekar, *and* N. S. Biradar, Bombay.

Magnetic susceptibilities of a number of hydrates have been measured along with the susceptibilities of their corresponding anhydrous salts, in the solid state, and have been compared with those calculated for these hydrates on the strict additivity basis. The results show that the percentage deviation of the observed values from calculated specific susceptibilities of these hydrates bears no generalised relation of any nature with the total heat of hydration. The percentage deviation per molecule of water of crystallisation has been found to become less and less as the heat of hydration per molecule increases.

The deviation in the molecular susceptibility from additivity rule is greatest in the hydrate containing the least number of molecules of crystallisation, and tends to decrease as the number of molecule of water of crystallisations increases. The heat of hydration per molecule of water of crystallisation increases in the same order as the deviation in x_M per molecule. The departure from the additivity rule has been explained on the basis of bindings between the molecules of water of crystallisation and the anhydrous salts.

Susceptibilities of some hydrated and anhydrous substances have also been deduced from the susceptibilities values of their aqueous solutions. A comparison of the values of the susceptibilities of hydrated obtained from solutions with those of anhydrous salts also from solutions shows that (i) the diamagnetism due to water of crystallisation is not strictly additive in solutions and (ii) the effect of hydration of ions is greater in the case of solutions of the anhydrous salts than that in the solutions of the hydrates.

19. Magnetic Study of Some Alkali Salts of Organic Acids.

Mata Prasad, S. S. Dharmatti *and* D. D. Khanolkar, Bombay.

A large number of salts of lithium, sodium and potassium with organic acids have been prepared in a chemically pure state and their susceptibilities have been measured by a modified form of Gouy's balance. A linear relation has been found to exist between the molecular susceptibility and the number of electrons in the cation in the case of the alkali salts having the same anion. This relation has been used to determine the susceptibilities of a large number of anions in combination with lithium, sodium and potassium ions. These anion values have been further employed to calculate the ionic susceptibilities of lithium, sodium and potassium. The value of the susceptibility of the CH_2 group has been determined for the homologous series consisting of formate, acetate, propionate, butyrate, palmitate and stearate of lithium, sodium and potassium. The results have been examined in general in the light of conclusions arrived at from the study of salts of organic and inorganic acids of metals of the second group of the periodic table made by Prasad and co-workers.

20. The Heat of Combustion of Resonating Molecules.

S. K. K. JATKAR *and* (Miss) S. B. KULKARNI, Bangalore.

The heat of combustion of aromatic molecules agrees with the value calculated on the basis of equal resonance between Kekule and Claus (centric) structures. The binding energy of the para linkages in the latter was calculated on basis of inverse proportionally between the energy of a bond and the internuclear distance. The following table gives the results.

Energy of benzene and substituted compounds.

Compound	Kekule	Centric	mean	observed
Benzene	828	743	785.5	788
Diphenyl	1601	1533	1517.0	1510
Styrene	1104	1025	1064.0	1054
Pyridine	712.3	632	672.0	669
Indole	1064.0	954	1026.0	1085
Toluene	986.0	901	944.0	945
Aniline	871.0	784	828.0	820
Phenol	795.0	709	752.0	745
Naphthalene	1325.0	1158	1242.0	1248
Anthracene	1822.0	1573	1698.0	1706
Quinoline	1209.0	1050.6	1128.8	1123

21. Molecular Refraction.

S. K. K. JATKAR, R. J. SUJIR *and* B. R. Y. IYENGAR, Bangalore.

The new equation for molecular refraction has been applied to interpret quantitatively the variation of refractive index of binary mixtures of chlorobenzene, isopropylalcohol, nitrobenzene and benzene in cyclohexane, hexane, carbontetrachloride, and benzene with varying concentration.

The molecular refractions of i-propylalcohol, benzene and chlorobenzene in hexane and chlorobenzene in carbontetrachloride and benzene, and i-propylalcohol in benzene do not vary with concentration showing the validity of the new expression for molecular refraction. In the case of chlorobenzene in cyclohexane the molecular refraction shows a little variation in the dilute regions and in the case of nitrobenzene and benzyl alcohol in benzene the molar refraction increases with concentration.

In all cases it has been observed that the anomalous variation of molar refraction is mostly in dilute regions indicating that the solvent molecules are responsible for complex formations.

22. Electric Moment of Silica.

S. K. K. JATKAR *and* B. R. Y. IYENGAR, Bangalore.

The electric moment of silica calculated by the new equation $(\varepsilon - n^2)\frac{M}{d} = \frac{4\pi N\mu^2}{k(T-\theta)}$ (where 'θ' the critical temperature is 575°C $\alpha-\beta$ quartz inversion temperature) is 1.0D. Considering SiO_2 moment as a vector of two mutually tetrahedrally inclined Si-O bonds the moment (observed) of Si-0 bond is 0.86D. The true moment of a 'free' Si-0 bond is 0.86 × 2 (co-ordination number) 1.72D agreeing with the calculated value $e \times d \times \frac{Zsi}{Zsi+Zo} \times n$ where Z's are atomic numbers and $n=1/3$. At low temperatures $(\theta - O)$ the observed Si-0 moment is 0.43D so that the true moment of the free Si-0 bond is again 1.72D (0.43 × 4, the co-ordination number).

23. Apparent Molal Volume of Sodium Chloride in Aqueous Solution.

BALBHADRA PRASAD *and* SHYAMASUNDER PANDA.

The apparent Molal Volume (ϕ) of electrolytes should be represented by an equation of the type $\phi = \phi_0 + a\sqrt{c} + bc$ where 'a' is the same for all electrolytes of the same valence type. There has been a good deal of difference in the results obtained with different salts of the same valency type. To see whether the differences are due to experimental error or are real, density measurements have been made to an accuracy of two in a million with the help of two pyknometers of the same size, one containing the solution and the other containing the solvent at the same temperature. The theoretical value of 'a' is very nearly equal to the experimental value.

24. Influence of Temperature on *Joshi-Effect* in Iodine Vapour.

M. V. RAMANAMURTI, Banaras.

Studies of *Joshi-effect*, Δi were made in iodine vapour, in contact with the solid phase, at different temperatures, t in the range 20 to 60°C, over a potential range 200-1100 volts (rms), with A.C. indicator, diode 83V (RCA).

At a constant potential V, the discharge current, i increases markedly with t. Thus *e.g.*, at $t=20$ and 60°C, i_D in dark at 730 V, was respectively 642 and 1220. 'Threshold potential' V_m, increases with t from 320 at 20°C to 340 at 60°C.

Δi is +ve at low and -ve at large V. . The transition $+\Delta i \rightarrow -\Delta i$ occurs at a critical '*inversion potential*', V_c near V_m, and, in agreement with the general finding of Joshi (*Curr. Sci.*, 1947, *16*, 19), is potential reversible.

At fixed V, $+\Delta i$ and $+\%\Delta i$ increase with t while $-\Delta i$ and $-\%\Delta i$ decrease. Thus *e.g.*, at 315V, $+\Delta i$ and $+\%\Delta i$, 44 and 64 respectively at 20°C increased to 64 and 1600 correspondingly at 60°C. At 420V, $-\Delta i$ and $-\%\Delta i$, -300 and -53 at 30°C decreased numerically to -30 and -8 at 60°C respectively. Occurrence of $+\Delta i$ according to Joshi (*loc. cit.*) is due to a great porbability for photo-ionisation of the pre-excited molecules. Increase of t enhances pre-excitation, whence increased $+\Delta i$. Decrease with t of $-\Delta i$ is due to the deconditioning influence of t on the 'activated layer' postulated by Joshi (*Phy. Sec.* A *26*, 1946; *Curr. Sci.*, 1946, *15*, 281) for the occurrence of $-\Delta i$.

At a fixed V, near V_m, $-\Delta i \rightarrow +\Delta i$ occurs *progressively* with t, with the change of sign at an '*inversion temperature*' t_c. Thus *e.g.*, at 340 V, Δi is -102 (20°C), -54 (30°C), $+48$(40°C), $+66$(50°C) and $+210$(55°C). t_c is higher for larger V; *e.g.* t_c for 340 V is 35°C and 400V; 55°C. These results indicate *simultaneous* occurrence of $+\Delta i$ and $-\Delta i$; the larger in magnitude governing the sign of the net *effect*.

25. Influence of Frequency of Exciting Potential on the *Joshi-Effect* in Oxygen.

S. R. MOHANTY, Banaras.

The influence of the frequency f of the exciting potential on the *Joshi-Effect* Δi in oxygen enclosed in a Siemens' tube at 331 mm pressure 32°C has been investigated.

In agreement with Joshi's general findings (*Proc. Ind. Acad.*, 1945, A *22*, 389; *Curr. Sci.*, 1946, *15*, 281) Δi and the 'threshold potential' V_m decrease with *f*. Thus, at a constant current in dark $i_D = 3$, the relative *effect* $\% \Delta i$ was 42 at 50~ and diminished to 21 at 500~. V_m at the above values of *f* was respectively 2.7 and 0.7 *k*V (r.m.s.). When the ozoniser was fed with high frequency (3-11 megacycles) currents generated by a modified Hartely type oscillator, Δi was absent despite large currents obtained.

According to Parshad (*Nature*, 1944, *155*, 362), Δi represents a diminution of the displacement as distinct from the conduction or ohmic current. Proportion of the former increases with *f*. The variation with *f* of Δi is opposite. This and the non-occurrence of Δi under high frequency potentials when the condition is mainly dielectric do not support Parshad's view.

26. Studies of Joshi Effect in Aerial Currents.

N. ATCHUTA RAMAIAH *and* M. V. RAMANAMURTI, Banaras.

That an ozonizer-like vessel, when excited, behaves like a transmitter especially markedly under optimum conditions for *Joshi-effect*, Δi was emphasised by Joshi (B.H.U. *Journ.*, 1943, *8*, 103; *Nature*, 1944, 154, 147). Studies of Δi were made in the currents i picked up by an aerial when two Siemens Ozonizers A and B containing iodine vapour were excited separately (A—and B—) and simultaneously (AB—) by A.C. potentials V, of 50 cycles frequency over 0—2 *k*V.

At a fixed V, i and Δi under simultaneous excitation are additive of the corresponding quantities when excited individually. Thus, *e.g.*, under A—, B— and AB— excitations, i_D under dark is 17, 11 and 27 at 0.53*k*V and 80, 53 and 132 at 2.1*k*V respectively; while corresponding values for Δi are 12, 8 and 19 at 0.53 *k*V and 37, 27 and 57 at 2.1 *k*V respectively. $\% \Delta i$, however, does not follow this, for obvious reasons.

27. Periodic Reversal in Conductivity and of the *Joshi-Effect* in Iodine Vapour.

G. S. DESHMUKH, Banaras.

Earlier results reported occurrence of 'ageing' *i.e.*, a time variation in the conductivity i of bromine vapour excited under silent discharge at a constant applied potential V. Extension of these results to iodine vapour suggested by the non-identical rising and falling V-i characteristics observed during studies of the *Joshi-Effect* Δi in the above system revealed a spontaneous self reversal in the conductivity i under constant exciting conditions. The associated *Joshi-Effect* Δi, in iodine vapour 'aged' under the discharge at a constant applied V also showed a synchronous time variation in its magnitude. This reversal in i and Δi, is more pronounced at high temperatures and especially when the system is 'preheated' at a given temperature for about 300 minutes. The conductivity decreases during the 'rest period' *i.e.*, the interval between two successive exposures to discharge. Prolonged 'ageing' stabilizes i, the corresponding Δi, is, however, reduced appreciably (progressively).

28. Comparative Study of the Conductivity and the *Joshi-Effect* in Heterogeneous and Homogeneous Discharge in Iodine Vapour.

G. S. DESHMUKH *and* P. K. SHARMA, Banaras.

The non-identity of the rising and falling V-i characteristics indicative of hysteresis was observed during studies of the *Joshi-Effect* Δi in excited bromine and iodine. In iodine vapour hysteresis was comparatively more pronounced in presence of an annular coat of iodine than that observed in a homogeneous vapour phase. The influence of the presence of powdered iodine on the occurrence and the magnitude of hysteresis in iodine vapour excited under silent discharge has now been studied in some detail.

The exciting potential was increased progressively from 1.2 to 1.9 *k*V of 50 cycles frequency and was reversed to the initial minimum *viz.*, 1.2 *k*V; this being the 'threshold potential' V_m of the system. The current i was measured with a reflection galvanometer actuated by a 83V double diode. Two series of experiments were carried out. In the first series the total (secondary) current was passed through the detector. In the other set the N.F. oscillations were damped by introducing a high resistance in the L.T. circuit. This stabilised the conductivity i but reduced the magnitude of hysteresis and Δi appreciably. For example, at 1.2*k*V, by eliminating the H.F. components, the % increase in i_D and i_L due to hysteresis was reduced from 100 and 60 to 8 and 5.2 (*i.e.* by about 90%) respectively; the corresponding decrease in Δi and % Δi was about 80 and 70 percent respectively. This indicates that hysteresis orginates in the H. F. components which, according to Joshi's theory, are also the chief seat of i. Results obtained during a series of potential reversals show that i is greater for the falling applied V than that observed during its progressive increase. The percentage increase in the conductivity is, however, greater for i_D than for i_L and is maximum near V_m. Previous results have shown that the relative *Joshi-Effect* % Δi reaches prolonged 'ageing' and its increase due to packing of the discharge space with powdered iodine suggests its remarkable correspondence with Δi.

29. On the '*Sintering*' of the Surface Film as a Determinant of the Conductivity Under Discharge and of the *Joshi-Effect*.

G. S. Deshmukh, Banaras.

The marked dependance of the magnitude and even sign of the *Joshi-effect* Δi on the nature of the adsorption like electrode layer has been emphasised by Joshi. The influence of the applied potential V, temperature, the gas pressure p and the duration of 'ageing' on the behaviour of the boundary layer has been studied in some detail in case of halogens. The present work reports observations on the time hysteresis in the conductivity of excited bromine and iodine and the influence of 'rest period' of different durations on the variation of i stabilised under prolonged 'ageing'. In the case of bromine the conductivity increases with the duration of the 'rest period'; in iodine vapour, however, the current decreases by about 10-20% when the 'rest period' is varied from 30 to 720 minutes. This has been attributed to the marked difference in the behaviour of the adsorption layer of NaBr and NaI formed as a result of the interaction under the discharge of the excited vapour and the glass walls of the discharge tube. It is known that a film of sodium bromide sinters gradually even at room temperature. The adsorption of iodine on the surface of NaBr abrogates the effect of sintering. This suggests that the surface film of NaI should be comparatively more stable than that of NaBr. It is suggested that the increase in the % restoration of i with the duration of the 'rest period' observed in the case of excited bromine is due to the gradual sintering of the adsorption layer of sodium bromide. The decrease of i observed in excited iodine vapour after each successive 'rest period' may result from an increase in C_w, the total wall capacity of the system due to the greater stability of the adsorption layer of iodine or/and NaI and the increased rate of adsorption of iodine during the 'rest period.'

30. The Disparity in the Times for Current Suppression and Restoration in the Production of the *Joshi-Effect*: Influence of Intensity of Irradiation.

H. J. Arnikar *and* N. Gopalaswami, Banaras.

The finding of Prof. Joshi (unpublished results) that the time (T_R) for the restoration of i_L, the current under irradiation to i_D, the original value in dark, is sensibly greater than the time (T) for the photosuppression of the current, $-\Delta i$, has been the subject of general investigation in these laboratories. In the present work, the ratio T_R/T_S has been measured in bromine under conditions of constant voltage and frequency of A.C. supply, and various light intensities measured thermopilically. A 600-fold variation of intensity showed that the ratio T_R/T_S falls from 1.45 to 1.08. (4.95 *k*V and 500 cycles frequency). It is significant to note that this ratio tends to limiting values on both the high and low intensity sides, corresponding but not exactly coinciding with the changes in the *Joshi-effect*: whilst relatively, the *Joshi-effect* reaches saturation of about 40% at intensities $>$ 400, the ratio T_R/T_S continues to rise to a stationary value of 1.45 (by extrapolation). Precisely similar observations were made in the case of the exciting field of 2.31 *k*V and 50 cycles frequency.

The study of the ratio T_R/T_S under varying intensities of irradiation have confirmed the general finding of a close parallelism between this ratio and the magnitude of the *Joshi-effect*, which is consistent with Prof. Joshi's theory that photoelectric emission from the boundary layer formed in part by an adsorption of ions and excited molecules (produced under the discharge) is the primary factor in the occurrence of this *effect*.

31. The Occurrence of Hysteresis in the *Joshi-Effect*.

N. Gopalswami *and* K. S. Visvanathan, Banaras.

The phenomenon of hysteresis has been studied in Cl_2, I_2, and *air* (the last taken at a very low pressure) excited by alternating potentials of frequency 50 and 500 cycles per second, using a semi-ozoniser for Cl_2 and Siemens' ozoniser for I_2 and air. The applied potential was varied in the range, 1.88-4.30 kV for Cl_2, 0.37-0.51 kV for I_2 and 0.65-2.7 kV for air; first it was raised gradually to the maximum value of the range studied and then lowered to the initial value. The corresponding values of the current i_D and i_L observed when the ozoniser was (i) in dark (ii) irradiated by a 200-watt bulb, were measured by means of a reflection galvanometer after rectification of the current by a diode. Cl_2 was taken at 200 mm., I_2 at its vapour pressure at room temperature, which was between 1-2 mm; in the third case, the ozoniser contained only '*residual*' air after evacuation by the Topler. In the case of air, the effect of KCl was studied (i) by keeping it in a bulb connected to the annular space, and (ii) after inverting the ozoniser and thus filling the annular space with powdered KCl.

Both i_D-V and i_L-V characteristics show hysteresis but not to the same extent. Hence, the net *Joshi-Effect* Δi (*i.e.* i_L-i_D) as well as % Δi ($= \frac{\Delta i}{i_D} \times 100$) shows hysteresis. The *Joshi-Effect* at a particular applied potential is larger when V is diminishing than when increasing. Even when the *Effect* is compared at a difinite value of i, obtained once when V is being raised and again when V is being lowered, hysteresis is obtained. While hysteresis in the case of i_D-V is known, it is remarkable to observe such a phenomenon in i_L-V and especially in $\Delta i - V$ and Δi-i_D curves. Since, according to Joshi, the *Effect* is of surface origin and occurs chiefly in the High Frequency part of the discharge current, it would follow that the 'active electrode lyer' postulated by Joshi, as a function of the applied potential is not entirely potential reversible but that there is a lag between the two. It also follows that the proportion of H.F. in i_D remains greater when the potential is diminishing than when increasing.

While the *Effect* is obtained in '*residual*' air, and shows hysteresis, it is completely absent when the annular space is filled with KCl powder.

32. Inhibition of the *Joshi-Effect* in Br_2 due to Admixture with H_2.

K. S. Visvanathan, Banaras.

Detailed work in Br_2, a strongly electro-negative gas, subjected to ozoniser excitation has revealed the occurrence of both positive *Joshi-effect*, which is remarkable, as well as the expected negative *Effect*. As first observed by Joshi, the positive *Effect* is comparatively restricted to a narrow range of low exciting potentials near/belowV_m. Increasing the 'electron affinity' of the medium by admixing with it gases possessing high electron affinity such as chlorine enhance the negative *Effect* to as much as even 100%. Hydrogen taken alone gives the positive *Effect* only. As is to be expected from the poor electron affinity of hydrogen, admixing it with Br_2 reduces the magnitude of the negative *Effect* in Br_2. Increasing the proportion of H_2 in the mixture is followed by an enhancement of the positive *Effect* and a diminution of the negative *Effect* given at higher potentials. A still higher proportion of H_2 inhibits the negative *Effect* in Br_2 completely. These observations point to the importance of the electron affinity of the medium in relation to the production of the *Joshi-Effect*, which is in accord with Joshi's general theory of the phenomenon.

33. Comparative Time Variation of the *Positive* and *Negative Joshi-Effect*, produced in Chlorine and Iodine Vapour under 'Wall-influence.'

B. M. Shukla, Banaras.

The primary role of 'wall-influenced' discharge in enhancing the *Positive Joshi-effect* over a wide range of kV, away from V_m (Shukla, *Proc. Ind. Sci. Cong. Chem. Sec.* Abst. No. 19, 1947) facilitated to study the comparative influence of 'ageing' on $-\Delta i$ and $+\Delta i$. In chlorine the *positive Joshi-effect* distinctly decreased with time to a minimum, *e.g.*, at 9.6 kV, +16% Δi reduces to +5% Δi under 150 minutes discharge;

in Iodine $+\Delta i$, occurring only below V_m, changes sign. This time decrease of *Positive Joshi-effect* is akin to Photo-electric fatigue. However, *negative Joshi-effect* increases numerically, both in Δi, with 'ageing;' *e.g.*, for chlorine, at 8 *k*V, $-\%\Delta i$ increases from from 45 to 56 in $2\frac{1}{2}$ hours discharge.

The above distinct and reverse role of 'ageing' on $-\Delta i$ and $+\Delta i$ is sought to be explained on Joshi's 'Boundary layer' postulate. 'Ageing' enhances the 'activated-layer' formation, thereby decreasing the work-function ϕ, leading to an increased electron emission and subsequent formation of heavy negative ions under light. $-\Delta i$ increases thus. The simultaneous occurrence of $\mp\Delta i$ in Chlorine, is shown as a result of study of aerial current and influence of R and capacitance C (Shukla, *ibid*, No. 37, 1948), hence the observed *Joshi-effect* is $\Sigma \mp \Delta i$. Increase in $-\Delta i$ with time, subsequently decreases $+\Delta i$. This time variation study indicates the advantage of the widely occurring *negative Joshi-effect*, over the common Photo-electric effect which suffers fatigue.

34. Role of Cu_2O Electrode in the Discharge Space, in the Study of the Joshi-Effect in Topler Vacuated Ozoniser.

B. M. SHUKLA, Banaras.

The known behaviour of Cu_2O electrode under light and the significant role of photoelectrons as a determinant of the *negative Joshi-effect* has led to the following investigation:

The ozoniser, having Töpler vacuum and two L.T. leads, one for the small Cu_2O electrode freely hanging in the discharge space, and the other covering the outer glass surface spirally, was excited between 0.5-1 *k*V by 50 cycles frequency. Vacuo-junction was used as detctor throughout. Firstly, with the outer surface as L.T. electrode, no *Joshi-effect* was observed, possibly due to absence of a solid gas interface, its importance being emphasised by Joshi (*Curr. Sci.*, 1945, *14*, 175). Secondly, with the Cu_2O electrode as the L.T. one, $-55\%\Delta i$ was shown, rapidly decreasing with increasing V. The emmission of photo-electrons from this Cu_2O electrode accounts for the above negative *Joshi-effect*. Later, the ozoniser was 'aged' for 4 hours; and now the outer glass surface when used as L.T. electrode showed $-100\%\Delta i$. This finds explanation in the 'activated layer' formation due to the residual gas, the decomposition of Cu_2O under electrical discharge being not possible. After this, the Cu_2O electrode when used or the L.T., showed a $+4\%$ *Positive Joshi-effect*. This is probably due to an increased photoelectron emission from the 'activated glass layer' than from the small Cu_2O electrode itself. These photo-electrons from the glass surface reach the Cu_2O electrode and thus a $+\Delta i$ is obtained. The above study of the role of Cu_2O electrode is in conformity with the 'Activated layer postulate'.

35. Comparative Studies of *Joshi-Effect* in Chlorine and Air using metallic electrodes.

D. V. RAMANA RAO, Cuttack.

The production of *Joshi-effect*, $\mp\Delta i$ in Geissler discharges has been reported (Ramana Rao, Abst., communicated *Phys. Sec. Indian Sci. Cong.*, 1949). The medium was chlorine enclosed at 100 mm. pressure. The present work refers chiefly fo discharges in air at a very low pressure.

Five discharge tubes were taken, differing only in the length of the tube. They were excited electrically by feeding in D.C. potentials obtained from a point-to-plate rectifier energised by a H.T. transformer. The current in the dark, i_D, and under light i_L were measured by a reflection galvanometer actuated by a diode 85V.

The potential variation of *Joshi-Effect* is more marked and abrupt in air than in chlorine. Whilst in the case of chlorine the effect Δi was observable over a wide potential range, it was detected over a very narrow range exciting potentials in air. Thus *e.g.*, in the former case, $-\%\Delta i$ was 76 at 2.16 *k*V and 7 at 2.7 *k*V and in the latter, it was 43 at 2.84 and nil at 2.97 *k*V.

Deo reported that in ozoniser discharges, the relative *Joshi-effect* $-\%\Delta i$ increases with 'ageing' under discharge (*Proc. Ind. Acad. Sci*, 1945, *21*, 76). In Geissler discharges, however, $\%\Delta i$ decreases with continuous 'ageing', becomes nil and changes sign also. This decrease is more marked in air than in chlorine; *e.g.*, $\%\Delta i$ at 9.3 *k*V was -13, -5 and $+2$ at the start, after 10 and 20 minutes 'ageing' respectively in the tubes containing air whilst in the case of chlorine, $-\%\Delta i$ at 2.67 *k*V decreased from -8 in the beginning to -3 after 120 minutes 'ageing'.

Increase in the applied voltage at constant time and increase in the time of exposure to discharge at a constant exciting *k*V lead to the same result as seen above.

36. Potential Inversion of *Joshi-Effect* in SO_2 Gas under Silent Electric Discharge.

U. S. Dhar.

Observations of *Joshi-Effect* were made in pure SO_2 gas when both positive and negative *Joshi-Effect*, $\pm\Delta i$, were observed. The relative *Joshi-Effect* was found to be maximum at small exciting *k*V and decreased by increasing the applied *k*V, in complete agreement with the generality of findings in regard to Δi phenomenon. Furthermore, a moderate increase in the applied *k*V causes a precipitous decrease of Δi. The nature of the excited surface was found to exert a profound influence on the magnitude of the corresponding *Joshi-Effect*. Observations were made in presence of annular films of Na_2So_4, NaOH, SO_2 and $HgCl_2$. A preformed film of Na_2SO_4 does not influence markedly the corresponding *Joshi-Effect*, whilst this is favoured to a great extent by a coat of NaOH. A condensed surface film of SO_2 and a coat of $HgCl_2$ on the annular walls of the ozoniser were found to abolish the *Joshi-Effect* altogether. These results confirm the suggestions due to Prof. Joshi that $\pm\Delta i$ being fundamentally of surface origin, may be poisoned by SO_2 or HgS formed during the experimental conditions.

37. Influence of the Filament Current in the Diode Detection *Joshi-Effect* in Iodine Vapour in contact with Powdered Iodine.

S. N. Tiwari, Banaras.

Joshi observed the profound influence of enhancing the surface/volume ratio on the magnitude and the sign of *Joshi-Effect* by introducing powdered wall material in the discharge space. In the present work the annular space of a Siemens' tube was filled with finely powdered Iodine and the system excited by fields due alternating potential of 50 cycles frequency. The discharge current i was measured by a diode used as a half-wave rectifier. Series of observations were taken for the influence of the filament current on the corresponding Joshi-Effect. This last was positive *i.e.*, showed a photo-increase of current, at low filament currents, At larger currents the effect was ordinarily negative. The results are discussed in terms of the filament-plate capacity and the kinetic energy of the cathode emissions at various filament currents.

38. *Joshi-Effect* in Chlorine under Mixed Electric Discharge.

G. V. Bakore, Jaipur.

Studies of *Joshi-effect*, Δi were made in chlorine in a Siemens Ozonizer excited by A. C. potentials V of 50 cycles frequency over 1 to 2 *k*V. The influence on Δi of ring-metallic electrode, in contact with the excited gas maintained at various unidirectional potentials in the ranges -2.3 to $+2.3$ *k*V, was investigated. The threshold potential V for the A.C discharge is 1.1 *k*Vand glow passes between the ring-electrode and the L.T. of the ozonizer at +or−1.7. *k*V.

The general variation of Δi or % Δi with applied A.C. potential, $\backsim V$, *viz.* maximum near V_m and a decrease thereafter, is the same at all fixed electrode potentials.

At a constant $\backsim V$; i_D under dark was unaltered when the ring-electrode potential varied between +and -1.7 *k*V; under the mixed discharge, however, i_D increases with positive ring-potential and decreases with a numerical increase of the negative potential.

Δi and % Δi at a fixed $\backsim V$ decrease with increase of +ve ring electrode potential and slightly increase with a numerical rise in the negative potential, between $+1.7$ and -1.7 *k*V. Thus *e.g.*, at an $\backsim V=1.2$ *k*V, Δi 105 decreased to 73 and %Δi; 71 to 52 for an increase 0 to $+1.7$ *k*V on the ring; and corresponding to $\backsim V=1.9$ *k*V, Δi 13 increased to 24 and %Δi, 5 to 9.4 for an increase 0 to -1.7 *k*V on the ring. This is attributed to the +ve or −ve electrode potentials being less or more favourable respectively for the 'space charge' due to negative ion formation responsible for Δi (Joshi, *Phy. Sec.*, A **26**, 1946; *Curr. Sci.*, 1946, *15*, 281).

Under the mixed discharge at a constant $\backsim V$, Δi and % Δi increase with numerically increasing ring potential (+ or −). Thus *e.g.*, at $V=1.7$ *k*V, Δi and % Δi increase

80—100 and 27—32 respectively for an increase +2.0 to +2.3 *k*V on the ring electrode. These results indicate that Δi is characteristic of the electrode-surface and not of the conductivities.

39. Charge and Stability of Colloids—Part XIV. Effect of Non-Electrolytes.

A. C. Chatterji *and* Ram Nath.

(1) The effect of non-electrolytes such as propyl alcohol, isopropyl alcohol, butyl alcohol, glycol, glycerol and acetone on the stability of arsenious sulphide sol have been studied. (2) It has been observed that the variations in the coagulation concentration of an electrolyte ($BaCl_2$) and the adsorption of oppositely charged ions of the same electrolyte do not always go hand in hand.

40. Supersaturation of Liquids in Liquids.

A. C. Chatterji, Ram Gopal *and* R. P. Rastogi, Lucknow.

A brief review of the previous work on supersaturation of liquids in liquids is given, from which it appears that the existence of supersaturation in liquid-liquid systems is still an unsettled problem and requires a further thorough and extensive study. With this aim in view a few systems *e.g.* aniline in water, water in aniline, nitrobenzene in water, phenol in water, and O-nitrophenol in water, have been tried. Although the results are not yet conclusive, they appear to show, however, a negligible supersaturation. It is pointed out that existence of a very low interfacial tension probably does not completely account for this phenomenon.

41. Supersaturation Limits of Non-aqueous Solutions—Part I.

A. C. Chatterji *and* A. N. Bose.

Limits of supersaturation in non-aqueous solutions of non-electrolytes have been studied. The value of $(T_S - T)$ has been calculated and these values fall in three different categories. From the values of $(T_S - T)$ the value of the radius of the stable crystal nucleus has been calculated. The value of '*r*' has got the same order in different systems *i.e.* the order is 10^{-6} cm.

42. Supersaturation Limits of Non-aqueous Solution—Part II. The effect of heating on the limits of supersaturation.

A. C. Chatterji *and* A. N. Bose.

The effect of heating on the limits of supersaturation of non-aqueous solutions of non-electrolytes has been studied. The effect of heating is observed in most of the systems. The product of concentration (c) and the fluidity ϕ has been calculated. It is found for the systems having $(c\phi)$ value more than 30, heating effect is negligible. Certain exception to the $c\phi$ rule are noticed. These are accounted for by the low mutual affinity among the molecules of the solutes.

43. Variation of Relative Viscosity with Temperature—Part IV. Organic Solutes in Non-aqueous Solvents.

A. C. Chatterji *and* A. N. Bose.

The variation of relative viscosity with temperature has been studied. In most of the systems studied here the value of $\frac{\delta}{\delta t}\left(\frac{\eta_s}{\eta.}\right)$ is negative but for the systems of butyl- alcohol phthalic acid, butyl alcohol-succinic acid and propyl alcohol succinic acid the value of $\frac{\delta}{\delta t}\left(\frac{\eta_s}{\eta.}\right)$ is almost zero at lower concentrations. This may be due to the fact that the molecules of butyl alcohol and propyl alcohol are less associated than the molecules of methyl alcohol.

44. Variation of Absolute Viscosity with Temperature—Part V. Organic Solution in Non-aqueous Solvents.

A. C. CHATTERJI *and* A. N. BOSE.

The variation of viscosity with temperature of non-electrolytes in non-aqueous solvents has been studied. It has been observed that the simple equation of Andrade $\log \eta = A + B/T$ is applicable to the most of the systems studied here. The value of the constants A and B of the above equation have been calculated and it has been found that A is the same both in aqueous and non-aqueous media while B changes from solvent to solvent.

45. Variation of Absolute Viscosity with Concentration—Part VI. Organic solutes in non-aqueous solvents.

A. C. CHATTERJI *and* A. N. BOSE.

The viscosity of non-electrolytes in non-aqueous solvents has been studied at different concentrations. It has been found that Taimis second equation $ln \ \eta \ \theta + \phi$ is applicable to the most of the systems studied here. The value of the constants, θ and ϕ, of the above equation have been calculated.

46. The Effect of Time and of Concentration on the Syneresis of Sodium Oleate Gels in Pinene and Xylene.

MATA PRASAD *and* V. SUNDARAM, Bombay.

The effect of time and concentration of soap in the syneresis of gels of sodium oleate in pinene and xylene has been studied. Syneresis starts spontaneously immediately after the gel sets. The amount of liquid exuded by the gels at any interval of time since the commencement of syneresis decreases with an increase in (1) the time interval and (2) the concentration of the gel. The gel containing 2 per cent sodium oleate in xylene has been found to behave abnormally. The equation $X^a = Kt$ for the rise of liquids in capillaries is found to be applicable to the process of syneresis, the value of 'a' varies with the concentration of gels; it is greater, the more dilute are the gels.

47. Some Anomalous Dipole Moments.

S. K. K. JATKAR *and* (MISS) S. B. KULKARNI, Bangalore.

Part I Hydrogen and Halogens.

Dipole moment of fluorine, chlorine, bromine and iodine in pure liquid state and that of iodine in various solvents has been calculated by applying the new equation. The small values of the dipole moments 0.01 to 0.4 in the case of hydrogen and halogens have been explained as due to the resonance structure $\overline{X}^- - X^+$. The moments are proportional to the cube of the internuclear distance and the ionic character calculated as $i = \frac{b}{e\gamma}$ varies linearly with r^2. The variation of the moment of iodine in different solvents is ascribed to the loosely bound iodine solvent complexes, wlich goes hand in hand with the variation of colour of the solvent.

Part II. Symmetrical di- and trisubstituted benzenes.

In continuation of the previous work on the moment of *p*-quinone, *p*-dinitro and *sym* trinitrobenzene etc., the moment of *p*-di—chloro,—bromo and iodo-benzene has been interpreted as due to the resonance in the symmetrical structures, the ionic character being proportional to the square of the distance.

Part III. Hydrogen peroxide, hydrazine and *para* nitroaniline.

The dipole moments of hydrogen peroxide, hydrazine and *para* nitroaniline in pure liquid state as well as in various solvents have been calculated by applying the new relationship $(\epsilon - n^2)\frac{M}{d} = \frac{L\pi N b^2}{KT}$ The moments calculated from pure liquids and concentrated solutions indicate the change in kT from 1 kT to ½ kT in the case of $H_2 0_2$, NH_2NH_2 and p-$NH_2C_6H_4NO_2$. The moments 2.1D for H_2O_2 and 1.5D for NH_2NH_2 are explained as due to free rotation along 0-0 and N-N. The new value moment of para-nitraniline 5.2D is the sum of the moments of aniline and nitrobenzene.

48. Nature of Chemical Bond.—Part III. Molar Refraction of Solids.

S. K. K. Jatkar *and* P. K. Bhandari, Bangalore.

The molar refraction R (Newton) $= (n^2 - 1\ \frac{M}{d}$ of solids such as oxides and halides of alkalies and alkaline earths are given by $\frac{4\pi N}{3} r^3 \cdot \frac{Za \text{ or } Zb}{(Za + Zb)} v^2$ where r is the interneuclear distance, Za and Zb are the atomic numbers and v the valence. The refraction given by Lorentz Lorenz' formula does not give as concordant results as the Newton's equation. The ratio $Za/(Za + Zb)$ is proportional to the partial ionic character given by dipole moments.

49. Formation of Formaldehyde during the Interaction of Carbon Monoxide and Hydrogen under Silent Electric Discharge. Part II. Influence of the Semi-ozoniser Excitation.

R. N. Sahasrabudhey *and* T. V. Sathyamurthy, Banaras.

The arrangement of the apparatus was the same as described earlier (*Proc. Ind. Acad. Sci.*, *27*, 366), but instead of a Siemens' ozoniser a wire-in-cylinder type of discharge tube—the semi-ozoniser—was used as the reaction vessel.

Experiments were conducted with CO-H_2 mixtures in 1: 1 ratio, at 9.6 *k*V and 500 cycles with the semi-ozoniser excited electrically in the normal and the reverse manner. In the former the inner electrode (the axial copper wire) served as H.T. and the winding on the glass outside as the L.T., and in the latter vice-versa. In neither set of experiments was the quantity of formaldehyde enough to permit quantitative estimation, although in the latter case evidence of its formation was decisive as indicated by Schiff's test. This is suggestive, perhaps, of the important role of the *surface* in this reaction.

50. Behaviour of Carbon Monoxide under Silent Electric Discharge: Influence of Temperature.

T. V. Sathyamurthy *and* S. M. Deshpande, Banaras.

Investigations on the behaviour of carbon monoxide under silent electric discharge reported earlier (*Proc. Ind. Sci. Cong.*, *33*, Part III. *Chem. Sec.* Abst. No. 52) have now been extended with respect to the influence of temperature.

Pure carbon monoxide filled at different pressures *viz.*, 230, 300 and 400 mm in Siemens' glass ozoniser was subjected to silent electric discharge at appropriate threshold potentials and 500 cycles frequency. Time variation of the pressure was observed at 30°, 40°, 50°, 60°, and 70°C respectively.

On switching on the electric field there is a continuous but gradually decreasing fall in pressure until a steady equilibrium pressure is reached. This fall in pressure is ascribed to the self-condensation of CO. It is directly proportional to initial gas pressure. The time taken to reach the equilibrium pressure also decreases with rising temperature indicative of an over-all increase of the rate of change with temperature. The last factor is, however, unfavourable to condensation of carbon monoxide as such under the change, which is also to be anticipated from general theories of polymerization and condensation.

51. Influence of Ultraviolet Light on the Capacity of Electrodes in an Electrolyte at Low Frequency.

D. SINGH *and* U. S. NANDI, Banaras.

The measurement of capacity of electrodes placed in an electrolyte at different frequency was carried out by means of a Wheatstone's bridge of the alternating current type in dark and under ultraviolet radiation. Two valve transmitters with 6L6 were designed and the beat frequency (usually 600 to 1520 cycles/second) was employed as the the source of alternating current for the bridge. The source of ultra violet light was a quartz mercury vapour lamp working at 220 volts and 2.5-2.7 amperes current; it was placed at a distance of 25 cms from the electrolytic cell. The electrolytes used were hydrochloric acid and silver nitrate of various concentration contained in a silica cell, with two bright platinum electrodes of 1 sq.cm area fixed vertically, the inter-electrode distance being 2.2 cms. It is observed that the capacity decreases as the frequency increases. When the values of the capacity were plotted against the square of the corresponding frequencies the curve obtained was a hyperbola, the general equation is $xy+dx+\beta y=K$- When the electrolytic cell was irradiated with ultra-violet light at constant frequency the capacity decreases; the percentage decrease in capacity diminishes with the increase of frequency.

52. A New Photo Compound of Anthracene.

(Miss) K. K. ROHATGI *and* S. N. MUKHERJEE, Jadavpur.

In course of the study of the quenching of fluorescence in non-aqueous solvents by organic quenchers, it was observed that by irradiating a soln. of anthracene in CCl_4 with ultraviolet light ($\lambda=3650A$) there was evidence of the formation of a photo-compound. After a period of slow reaction, the process went on with an accelerated rate as studied by the rise in fluorescence intensity with time of 3 hours. With the progress of reaction, wave-length of the emitted light changed from violet to blue (4200 →4650A) and the region of max. absorption shifted towards the shorter wave-lengths.

In pure CCl_4 the reaction proceeded slowly, never reaching an appreciable fluorescence intensity. But with the addition of increasing amounts of C_6H_6, the reaction appeared to be accelerated, although in pure benzene soln., evidence of a late reaction was observed on prolonged exposure.

The above interaction is being followed by absorption study in a spectrograph and also by measuring the percentage transmission of incident radiation by means of a photocell in Lumetron colorimeter.

53. Silver Catalysis, Basic Catalysis, and Catalysis by undissociated Molecules of acetic acid in the reduction of Silver Ion by Ferrous Ion.—Part A.

BAL KRISHNA *and* SATYESHWAR GHOSH.

A detailed study of the reaction between silver ion and ferrous ion has been made. The order of the reaction is dependent upon the quantity of silver which is a reaction product and which remains in a state of continuous flux owing to a simultaneous formation and precipitation of colloidal silver. The reaction is trimolecular where the catalytic surface increases proportionately with the mass of silver reduced. If we omit silver catalysis from consideration, the specific reaction rate shows tendency towards bimolecularity.

Apart from silver, a number of other very important factors are involved which control the reaction velocity :—

(1) Basic ions, like carbonate, acetate, and borate exert a strong accelerating effect upon speed of the reaction.

(2) For a given pH *i.e.* at a constant acid base ratio, it has been shown that speed of the reaction is independent of hydroxyl ion concentration, but depends upon total concentration of the buffer. In other words the reaction shows the phenomenon of *general base catalysis*.

(3) Undissociated molecules of acetic acid play the role of a positive catalyst.

(4) In contradiction to the existing view it has now been definitely established that Hydrions retard the reaction velocity,

54. Silver Catalysis, Basic Catalysis, and Catalysis by undissociated Molecules of Acetic Acid in the Reduction of Silver Ion by Ferrous Ion—Part B.

BAL KRISHNA *and* SATYESHWAR GHOSH.

The reaction between silver ion and ferrous ion is the first instance from the inorganic reactions which shows the presence of general base catalysis. The present concept of acids and bases and acid-base catalysis as given by Bronsted is inadequate to explain the presence of basic catalysis as shown in the reduction of silver ion by ferrous ion. The present concept of acids and bases needs revision in order to meet the demands of experimental kinetics observed here.

Further, the reaction between silver ion and ferrous ion shows that the catalysis by hydrions is different from that of undissociated molecules of an acid. Bronsted's assumption *viz.* that the catalysis by undissociated molecules of the acids is identical with catalysis by hydrogen ions, is erroneous.

55. On the Question of the Existence of a Definite Base Saturation Limit of Layer-lattice Silicates.

R. P. MITRA *and* K. S. RAJAGOPALAN, Delhi.

Many layer-lattice silicates including the so-called clay minerals readily take up cations (or, bases) from 'contact' solutions. As a rule the greater the valency and the concentration of the cation and the higher the pH of the solution, the larger is the amount of cations taken up by the solid phase. This raises the important question as to whether a definite base saturation limit in the case of these silicates at all exists and, if so, on what factors it depends. Investigations on hydrogen mica obtained by replacing the exchangeable K ions of finely ground muscovite by H ions show that such a limit does exist and the limiting value indicates the total amount of cations taken up by the solid in exchange for (a) the H ions on the surface of the platelets acquired by the replacement of the exposed K ions by H ions in preparing the hydrogen mica, and, (b) H ions dissociated from the OH groups of the mica lattice which have become exposed through hexagonal rings of oxygens as a result of grinding the mineral. The amounts of both these categories of H ions can be accurately determined from two sharp inflexions in the potentiometric titration curve of the hydrogen mica with a strong base (Mitra and Rajagopalan, *Nature*, 1948, p: 104).

56. On the Alleged Cation Binding Power of the so-called Broken Bonds of Layer-lattice Silicates.

R. P. MITRA *and* K. S. RAJAGOPALAN, Delhi.

The layer-lattice silicates *e.g.*, micas, being crystals of the ionic type, their mechanical comminution must give rise to sheets terminating in equal numbers of positively and negatively charged ends, or, poles at the lateral surfaces and if the negative ends of the broken bonds should at all remove cations from a contact solution as postulated by some investigators, the positive ends must simultaneously take up an equal number of anions as otherwise more anions than cations would be left in the liquid phase when the solid is separated from it, *e.g.*, by filtration. Experiments with finely ground mica show that anions like Cl′ and SO_4'' are not at all taken up by the solid though it does remove appreciable quantities of cations from the solution. Apparently, the broken bonds cannot be held responsible for the cation binding power of the ground mineral. On the other hand, the observed cation binding capacity can be completely accounted for if it is recognised that the cations are simply taken up in exchange for (a) the exposed K ions of the mica particles and, (b) H ions dissociated from the OH groups of the lattice which have also become exposed through hexagonal rings of oxygens as a result of the grinding. Both (a) and (b) can be accurately estimated, (a) by extracting the potassiums with a dilute mineral acid and analysing for K in the acid extract, and (b) by potentiometric titration of the mica with a strong base. The maximum quantity of cations which is taken up from a salt solution is then found to be equal to the sum of (a) and (b).

57. Some Common Electrochemical Features of Kaolinite and Asbestos.

R. P. Mitra *and* K. S. Rajagopalan, Delhi.

The 2.0 micron fraction separated from ground asbestos (a Merck specimen) on being leached with dilute HCl gave in the leachate 14.0 milliequivalents of Ca reckoned per 100 gms of the mineral. Potentiometric titration of a 1.0 percent aqueous suspension of the resulting 'hydrogen' asbestos with NaOH gave two marked inflexions at *p*H's 8.7 and 10.0. The base combining capacities calculated (in terms of milliequivalents per 100 gms of dry matter) at the second and first inflexions were as 2:1. Similar observations had been previously made on the mineral Kaolinite (Mitra, Bull. No 4, *Indian Soc- Soil Science*, 1942, p 41). This similarity is in harmony with the recent finding from x-ray studies that in respect of its lattice structure, asbestos resembles the platy mineral, Kaolinite, more than the double-chain silicates, amphiboles.

58. An Electrochemical Method for the Identification of Illite in Soils and other Argillaceons Sediments.

R. P. Mitra *and* K. S. Rajagopalan, Delhi.

Identification of the clay mineral, illite, in soil and other argillaceons sediments, e.g., shales, is usually done by x-ray and thermal methods. An unequivocal differentiation from the other allied mineral, montmorillonite, is often difficult to make using, even, the x-ray technique. Quite dependable criteria have, however, been found to be provided by the electrometric titration curves of the hydrogen or, acid forms of the two minerals. Hydrogen montmorillonite, as a rule, shows only one pronounced inflexion in its titration curve with NaOH, or, KOH at about pH 8.5. Hydrogen illite, on the other hand, gives as many as three inflexions, one at about pH 6.5, and the other two at pH's nearly 8.0 and 10.5. The base combining capacities calculated (in milliequivalents per 100 gms of the hydrogen illite) at the third and second inflexions are as 3:1. Similar features are shown by (the acid form of) mica itself in a finely ground state (Mitra and Rajagopalan, *Nature*, 1948, p. 104). This similarity confirms the essentially micaceous structure attributed to illite on the basis of x-ray studies.

59. Drought Resistance of Plants in Relation to Hysteresis in Sorption. I. Hydration and Dehydration of the Leaves of Certain Drought Resistant and Drought Sensitive Plants.

K. Subba Rao, M. Bhimasena Rao *and* B. Sanjiva Rao, Bangalore.

A new approach to the problem of drought resistance of plants has been made from the point of view of Hysteresis in Sorption. Balsam, Grass, Paddy, Ragi, Wheat and Oats were chosen for the study. The leaves of these plants were subjected to successive dehydration and hydration in a quartz fibre spring balance.

Hysteresis effect is observed in all the systems and the hysteresis loop disappears after a certain number of hydrations and dehydrations. In the early stages, the capillaries of the leaf are made up of fairly rigid walls. The cavities entrap water and cause hysteresis. The entrapping effect is due to the rigidity of the leaf tissue. It is likely that this rigidity of the leaf tissue is a factor of importance in enabling the plants to conserve water during periods of drought.

On successive hydration and dehydration of the leaf, there is a fall in the hydration capacity at saturation pressure. This is due to the denaturation of the protoplasm and a decrease in the hydrophilic character.

The relative positions of the hydration isotherms of the leaves indicate that in the relative humidity range of 0.5-0.95 the six plants show a gradation in the water holding capacity. At any particular humidity in this range, balsam takes the lowest and Oats the highest amount of water. The six plants can be arranged in the increasing order of drought resistance as follows,—Balsam, Grass, Paddy, Ragi, Wheat and Oats. Balsam is the least and Oats the most drought resistant. In accordance with the cavity theory of sorption hysteresis, there is in balsam a preponderence of wider cavities and in Oats narrower ones.

60. Drought Resistance of Plants in relation to Hysteresis in Sorption. II. Adaptability of the Ragi Plant to varying Conditions of Soil Drought.

K. SUBBA RAO, M. BHIMASENA RAO *and* B. SANJIVA RAO, Bangalore.

The principle of adaptability of drought sensitive plants to severe drought conditions is one of great importance and has been extensively studied by Russian workers. Whether during this adaptation, any change is produced in the capillary structure of the leaf has been studied with reference to Ragi as the experimental plant. Ragi plants A, B, C, and D were grown in soil droughts of 65%, 47%, 40% and 36.5% respectively of the total water holding capacity of the oil. There was a marked difference in the growth, height and yield of the four plants.

When the plants were 80 days old, the blades were removed and subjected to a series of dehydrations and hydrations at 30°C in a spring balance. Hysteresis is exhibited in all the cases. The hydration dehydration isotherms and the hysteresis loops are nearly coincident. These indicate that the cavities and open pores in the blades of the four plants are almost of the same size.

There is however a regular variation, though small, in the smallest cavity neck radius. The radius in D is smaller that that in A, those of B and C being intermediate between these two. It is probable that by extending the treatment of exposure of the plant to severe drought over a number of generations, the small differences to the capillary structure of the leaves may become more prominent.

The amount of water lost in the initial dehydration of the leaves seems to be related to the age of the plant. The leaves of 80-day old plants lost approximately 350 gms. of water per 100 gms. or dry leaf, whereas those of 120-day old plants lost 255 gms.

61. Hysteresis in Sorption. XVII. Sorption of water on hardened sericin (silk gum).

K. SUBBA RAO, M. BHIMASENA RAO, A. R. VASUDEVA MURTHY *and* B. SANJIVA RAO, Bangalore.

The behaviour of sericin with regard to the hysteresis effect in the sorption of water has already been indicated (*Proc. Ind. Sci. Congress*, 3,56,1946). The behaviour of sericin hardened by formaldehyde and basic chromium sulphate has now been studied. The hardened sericin was subjected to a series of hydration and dehydration at 30°C. A permenent hysteresis loop has been obtained Tde loop has been reproduced at the 9th cycle of hydration and dehydration with formaldehyde hardened sericin and at the 8th cycle with chromium sulphate hardened sericin.

A permanent and reproducible hysteresis loop is characteristic of a rigid gel (Rao K. S., *J. Phys. Chem.* 500.45,1941) whereas a dwindling and disappearing loop is characteristic of an elastic gel with solvating liquids. Sericin is an elastic gel like casein, egg albumin and gelatin (Rao G. N., Rao K. S., and Rao B. S., *Proc. Ind. Acad. Sciences* 221, 25, 1947), rice grain (Rao K. S., *Current Science* 266, 8, 1939) and gum arabic (Rao K. S., *Current Science* 19, 9, 1940) in losing the hysteresis loop initially exhibited in the sorption of water. On hardening, sericin loses its swelling property and behaves like a rigid gel. The cavities entrap water during dehydration and cause hysteresis. The entrapping effect persists even in the subsequent cycles of hydtation and dehydration.

62. Compression-expansion Hysteresis in Surface Films.

K. SUBBA RAO *and* B. SANJIVA RAO, Bangalore.

By employing the Adam surface pressure balance, the compression-expansion hysteresis of the films of sericin and egg albumin has been studied. The expansion curve is always below the compression curve and the hysteresis loop is reproducible. The loop has been scanned by subjecting the film to expansion at different points on the compression curve and to compression at different points of the expansion curve. The expansion scanning curves reach the low pressure end of the loop and the compression scanning curves reach the high pressure end. The compression-expansion hysteresis effect and the characteristics of the scanning curves are probably connected with the difference in the degree of hydration of the protein film.

Below the collapse point, the stearic acid film shows no hysteresis on compression and expansion. Above the collapse point however, the compression expansion curves do not coincide and the hysteresis loop obtained is nonreproducible.

63. Adsorption of Dyes on Mercury Surface.

D. D. KARVE, K. K. DOLE *and* B. W. KELKAR, Poona.

Study of the adsorption of different dyes on the surface of mercury has given very interesting results and some of them have been described in the present paper. Mercury-coated copper plates were suspended in aqueous solutions of different water-soluble dyes, for different time intervals and different concentrations of the dyes. The adsorption of the dyes was determined colorimetrically after washing the plates with pure double-distilled water and removing the adsorbed dye by N/10 acetic acid solution and estimating the dye in the acetic acid wash.

In general, adsorption increases with increase in the concentration of the dye, until the saturation of the surfaces is reached. It is observed that the adsorption varies with time and curves of the adsorption coefficient against time exhibit breaks at certain intervals. This indicates that the multi-layer theory of McBain is corroborated in these observations.

It is significant that in the case of neutral red colour of the solution changes to yellowish red, after adsorption by a mercury-coated copper plate. If the same yellow solution is used for adsorption by a fresh mercury plate, the adsorption coefficient increases, while Rubin S behaves exactly in the opposite way. Methyl orange behaves probably in the same manner as the neutral red except that the colour change is not observed.

In alkaline medium adsorption of neutral red substantially increases while the presence of acetic acid in the solution has no influence on the adsorption. Alkaline medium has the adverse effect on the adsorption of Rubin S.

Under identical conditions following is the order of increasing adsorption.

Rubin S ———— Neutral Red———— Methyl Orange.

Further work with other dyes is in progress.

64. Semipolar Single Bond—Part III. Ratio of specific heats for gases.

SAIYID SHAMIM-AHMAD.

The anomaly of the ratio of the specific heats for coloured diatomic molecules is put forward to support the hypothesis of the semipolar single bond—a hypothesis which also explains the reactivity and colour of these anomalous molecules. The influence of substitution on the value of γ is explained as also that of temperature. This decrease in γ is correlated with increase in reactivity at higher temperatures and both are shown to be due to the presence of the semipolar single bond. Dissociation into atoms is ruled out as the cause of increase in reactivity.

65. Semipolar Single Bond—Part IV. Semipolar Single Bond and Pauling's scale of Electronegativities—Part I.

SAIYID SHAMIM-AHMAD.

In the present paper an attempt is made to point out the defects of Pauling's interpretation of Electronegativity Scale on the basis of the concept of the semipolar single bond. The results of Pauling's approach are criticised on the basis that the bond type in the elements may be different from that in the compounds and secondly that the results obtained from Pauling's interpretation are highly surprising and sometimes clearly against facts. Most evident are the cases of the alkali hydrides and the coloured molecules. The calculations of the ionic percentage of bonds is open to the serious question as Pauling supposes the covalent molecules to have more than 50% ionic character whereas many salts are supposed to be mainly covalent in nature.

66. Supersaturation Limits of Solutions—Part VII. The Influence of Apparent Ionic Volume and Similar other properties of Ions on the Facility of Spontaneous Crystallisation of Electrolytes from Aqueous Solutions.

RAM GOPAL, Lucknow.

It is shown that, in general, the electrolytes with large apparent equivalent volumes should crystallise out with ease and those of small apparent equivalent volumes should crystallise out with difficulty from aqueous solutions, A number of examples have been cited in support of this statement. Influence of other properties e.g, entropy etc., similar to apparent equivalent volume, of electrolytes on spontaneous crystallisation has also been referred to in this communication,

67. Supersaturation Limits of Solutions—Part VIII. The Physical Significance of the Constancy of the Expression $(T_s\text{-}T)\lambda$.

RAM GOPAL, Lucknow.

Considering the heat of solution λ of the solute as its lattice energy when kept in contact with water, an explanation of the constancy of the expression $(T_s-T)\ \lambda$, found experimentally in many cases, has been advanced.

68. Influence of Oxidising Agents on the Adsorptive Power of Charcoal: I. Potassium Permanganate.

SUDHAMOY MUKHERJEE *and* SUKHAMOY BHATTACHARYA, Calcutta.

A study has been made of the variations of the adsorptive powers of activated and non-activated charcoals on boiling with 0.02N, 0.1N, 1.0N and 25N solutions of potassium permanganate. The adsorptive powers of both types of charcoal for methylene blue, iodine, caramel and acetic acid (only for non-activated charcoal) at first increase and then decrease on gradually increasing the concentration of permanganate and the optimum occurs with 0.1N solution. Non-activated charcoals are more susceptible to activation than activated ones. No further change is noticed on raising the concentration above 1.0N. Alkaline permanganate behaves in the same manner as acid permanganate.

The treatment of charcoal with potassium permanganate is accompanied with chemical interaction, involving the reduction of permanganate and oxidation of carbon to carbon dioxide. It has been suggested that 'activation' and 'over-activation' produced by the oxidation of the surface carbon atoms by permanganate bring about the observed effects.

69. Adsorption Method of Separating Constituents of Mixture.

M. GOSWAMI *and* B. K. MUKHERJEE.

Activated carbon and silica gel were tried as adsorbents. Silica gel prepared by different methods and having different pore space were tried. A constant boiling point mixture of 15% Methyl Alcohol and 85% Acetone by volume was the adsorbate. It has been observed that Carbon has preferential affinity for MeOH but Silica Gel preferentially adsorbs Acetone from the mixture and that the adsorption is more marked in the liquid phase than in the vapour phase. Previous works in this direction have been confined to mixtures of the same series of compounds consisting mostly of lower and higher boiling fractions of hydrocarbons and also on the adsorption of Methyl Alcohol and Acetone separately by Carbon or Silica Gel. Conclusions of previous workers that the higher the molecular weight and the lower the volatility of a substance the greater is its tendency to adsorb any solid can not be applicable in the present case as MeOH is of lower volatility and also of lower molecular weight than Acetone. Mixtures of the nature dealt with in the present work are often obtained in industrial practice and there exists no suitable method of separation specially when one of the constituents present is small in amount in comparison to the other.

70. The Ternary System Ag_2O—Per-iodic Acid—Water at 0°C.

P. P. Gyani, Patna.

The ternary system Ag_20—Per-iodic acid—water has been studied at 0°C. Three solid phases of compositions $5Ag_20.1_20_7$, $2Ag_20.1_20_7$, $3H_20$ and $Ag_20.1_20_7.4H_20$ have been shown to exist. The first two compounds have been isolated in the pure state and their composition studied. The Compound $Ag_20.1_20_7/4H_20$ is stable only in presence of excess of per-iodic acid and is decomposed by pure water with the separation of the compound $5Ag_20.1_20._7$

71. Theory of Ash Determination by two Conductance Measurements.

K. S. G. Doss *and* K. K. Gupta.

For calculating soluble ash % of sugar and sugar-products from electrical conductance measurements, Zerban and Sattler have suggested an empirical equation of the form—

$$\text{Ash }\% = \frac{k}{\text{M}}\,[1+px-qy] \quad \cdot\cdot \quad \cdot\cdot \quad \text{(A)}$$

where, M, p & q are constants

$$x = \frac{1}{\text{K}} \;\&\; y = \frac{\text{K}_1}{\text{K}}$$

K—Sp. conductance of sugar solution (5 gm. in 100 ml.) at 20°C.
K —Sp. conductance of acidified solution (200 ml. of above solution +5ml. of 0.25N HCl) at 20°C.

The above equation though evolved empirically, yields good results agreeing very well with the soluble ash determined by the chemical method. In the present work, the following equation has been derived on theoretical considerations :—

$$\text{Ash }\% = \frac{k}{\text{M}}\left[1+px-qy+\frac{(qy-px)^2}{1-px+qy}\right] \quad \cdot\cdot \quad \text{(B)}$$

Equations (A) and (B) are of the same form excepting for the term $\frac{(qy-px)^2}{1-px+qy}$

Even in extreme cases, the term was examined and found to be negligibly small as compared with the main term. Thus it is quite clear from the above discussion that empiricial equation of Zerban and Sattler can be supported theoretically. The significance of the constants in Zerban and Sattler Equation has been discussed.

72. Kineties of Development of Colour in Sugar Solution.

K. S. G. Doss *and* S. K. Ghosh.

An important cause of colour in sugar obtained from sugarcane is the caramelisation of reducing sugars during the sugar boiling process. A study of Kinetics of caramelisation was therefore undertaken. The colour development was studied by using a recording photo-electric sepectrophotometer.

The results show (1) that the absorption by heated solution of invert sugar continuously increases from the red to the blue end of the spectrum, (2) that the intensity of colour developed increases with the time of heating, (3) that the rate of colour development is not proportionate to the time of heating but is apparently autocatalytic and (4) that the sate of colour development in the initial stage of reaction is nearly proportional to the concentration of invert sugar but after the reaction has proceeded for about an hour the rate of colour development is much higher in the more concentrated solution.

73. Formation of Formaldehyde during the Interaction of Carbon Monoxide and Hydrogen under Silent Electric Discharge:—Part I. Influence of Temperature.

R. H. SAHASRABUDHEY *and* T. V. SATHYAMURTHY, Banaras.

The investigations reported earlier in these Absts. (also *Proc. Indian Acad. Sci.* 27, 366), have been extended.

The carbon monoxide-hydrogen mixture (ratio 1:1 by volume) at atmospheric pressure was circulated through a Siemen's glass ozoniser heated to different temperatures and subjected to silent electric discharge at an exciting potential of 9.6*k*V and 500 cycles frequency. Formation of formaldehyde was observed at 0.5°, 15°, 20°, 32°, 40°, 50°, 60° and 80°C.

The reaction velocity as judged by the volume of the gas mixture used up *viz.*, 415 cc at 0.5°C and 900 cc at 80°C appears to increase directly with temperature. The absolute yield of formaldehyde, however, is greatest- 0,057 gms- at 0.5°C and progressively decreases with rising temperature to 0.023 gms at 80°C.

The lower yields at higher temperatures cannot be due either to polymerization of formaldehyde (Auerbach and Pluddemann, 1914, *Ai*, 488) or to self-condensation of carbon monoxide as reported separately in these abstracts. It appears that formaldehyde which is the primary product of the reaction is destroyed irreversibly by secondary changes accelerated by rising temperature.

74. Molecular Radii of Lac and other natural Resins.

S. K. K. JATKAR *and* B. R. Y. IYENGAR, Bangalore.

The dielectric constant data on lac, manila copal, dammer and mastic resins have been utilized to calculate the 'molecular radii' by applying the new equation. An error in the previous interpretation of Bhattacharya has been pointed out. The molecular sizes follow the trend, mastic > manila copal > dammer > lac.

75. Supersonic Velocity in Gases and Vapours. (Dispersion in Carbondioxide).

S. K. K. JATKAR *and* R. J. SUJIR, Bangalore.

Velocity of sound in carbondioxide was measured by the supersonic method. While at room temperature the velocity was normal at 22 Kc/s, at 50 Kc/s there is a dispersion. However at 134°C at the same frequency the velocity was normal. Higher temperatures tend to displace the dispersion to higher frequency ranges.

76. Potentiometric Titrations of Oxidation Reduction Systems.

S. K. K. JATKAR *and* S. K. RAMASWAMY, Bangalore.

The potentiometric titration of mixtures of hydrogen peroxide, Caro's acid and persulphuric acid with sodium sulphite and permanganate has been carried out with a view to check the analysis by the usual Standard method and of Bodin's, Gleu's, Wolfstein and Makow's. It was found to be in satisfactory agreement with the Standard method.

77. Oxidation Reduction Potential of Hydrogen Peroxide, Caro's Acid and Persulphuric Acid.

S. K. K. JATKAR *and* K. S. RAMASWAMY, Bangalore.

Using the above equipment the oxidation reduction potential of hydrogen peroxide, Caro's acid and persulphuric acid at various pH has been measured and compared with theoretical values.

78. A Simple Laboratory Amplifier.

S. K. K. Jatkar *and* K. S. Ramaswamy, Bangalore.

The paper gives the details of mains driven push pull valve electrometer circuit suitable for the accurate measurement of pH and of oxidation reduction potentials using ordinary radio tubes, a Tinsley vernier potentiometer and unipivot galvanometer.

Organic Chemistry.

79. Sulphur Dyes and Suphurised Vat Dyes: Part II. Constitution of Cibanone Yellow R.

K. N. Shah, B. D. Tilak *and* K. Venkataraman, Bombay.

The invalidity of the constitution proposed by Fierz-David and Geering (*J. Soc. Dyers Col.*, 1935, *51*, 50), for Cibanone Yellow R, a dye which is noted for its catalytic activity in the photochemical degradation of cellulose, is discussed. The purified dye, assumed to be homogeneous by Fierz-David, has now been shown by chromatography to be a mixture of several substances. The major fraction crystallised in curved orange needles, m.p. 368-70°, regarded as the essential tinctorial constituent of Cibanone Yellow R. Anthraflavone was among the other products isolated.

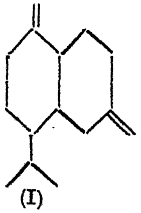
Elementary analysis of pure Cibanone Yellow R corresponds to the empirical formula $C_{45}N_{26}O_7S$, corresponding to three methylanthraquinone residues for one atom of sulphur. Reductive desulphurisation of the pure dye by treatment with Raney nickel and pyrolysis with zinc dust indicate that 2-methylanthraquinone molecules are linked together through the methyl groups by means of sulphur, as against the methane bridge between anthraquinone groups in the constitution proposed by Fierz-David.

A new structure for Cibanone Yellow R and the probable mechanism of its formation from 2-chloromethylanthraquinone are suggested.

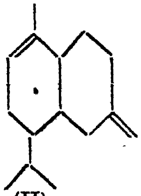
80. Structure of the Cadinenic Sesquiterpene Present in the Oil from the Oleo-resin of Hardwickia Pinnata.

Sukh Dev *and* P. C. Guha, Bangalore.

The dextro-rotatory sesquiterpene of *Hardwickia Pinnata* oil has been shown to be a mixture of two isomeric hydrocarbons, (I) and (II).



(I)



(II)

The above structures have been arrived at after detailed investigations. The results of dehydrogenation and ozonisation have confirmed the above structures. The position of the nuclear double bond has been established by an extension of Ruzicka and Sternbach's method.

81. On a New Synthesis of Penicillamine.

D. B. Dutt *and* P. C. Guha, Bangalore.

Acetone has been condensed with hippuric acid, in the presence of anhydrous sodium acetate, acetic anhydride and a trace of pyridine to give 2-phenyl-4-ispropylidene-oxazol-5-one in 60% yields. The oxazolone is readily converted to β, β-dimethyl-α-benzamido-acrylic acid or ester by water or the corresponding alcohols. Condensation of the oxazolone, acrylic acid and the methyl ester has been studied with thioacetic acid alone and in the presence of peroxides, alkoxides, sulphuric acid and piperidine as catalysts. In the absence of catalysts and in the presence of peroxides no reaction takes place at lower temperature while cyclisation of the acrylic acid takes place at higher temperature. In the presence of sulphuric acid a small trace of a new compound is formed which appears to be N-benzoyl-S-acetyl penicillamine. In the presence of piperidine condensation proceeds smoothly and on hydrolysis gives a compound which conforms with all the colour reactions of penicillamine. Work is in progress to confirm the structure of the amino-acid, which appears to be *dl*-penicillamine.

82. Schiff's Bases of 4:4′–Diamino Diphenyl Sulphide.

M. Raghavan, B. H. Iyer *and* P. C. Guha, Bangalore.

Raiziss *et al.* (*J. Amer. Chem. Soc.*, 1939, *61*. 2763 and *Proc. Soc. Exptl. Biol. Med.*, 1938, *39*, 339) have shown that although the therapeutic properties of 4:4′-diamino diphenyl sulphide and its acetyl derivative compared favourably with those of sulphanilamides, their high toxicity precluded their clinical use. The Schiff's bases of sulphanilamides and N^1-substituted sulphanilamides have all been found to be very effective against bacterial infections. (Molitov and Robinson: *J. Pharmacol.*, 1939, *65*, 405).

With a view to testing their activity, a number of Schiff's bases of 4:4′-diaminodiphenyl sulphide with melting points indicated below in parenthesis after each aldehyde, have now been prepared by reacting it with the following aromatic aldehydes. (1) Benzaldehyde, m.p. 176-177°, (2) m-nitrobenzaldehyde, m.p. 159-160°, (3) p-dimethylamino benzaldehyde, m.p. 231-232°. (4) p-diethylamino benzaldehyde, m.p. 155-156°, (5) salicylaldehyde, m.p. 207-208°, (6) anisaldehyde, m.p. 204-205°, (7) 3:4-methylene-dioxybenzaldehyde, m.p. 175-176°, (8) cinnamaldehyde. m.p. 178-179°, and (9) furfural, m.p. 103-104°.

83. Action of Nitrous Acid on Aryl-biguanides.

H. L. Bami, Bangalore.

Pellizzari (*Gazz. Chim. Ital.*, 1921, *15*, I, 224, 140) has obatined cyanoguanidine, and *o*-phenylene-cyanoguanidine from biguanidine and *o*-phenylene-biguanide respectively by the action of nitrous acid in aqueous solution. During the course of work on substituted biguanide derivatives as potential antimalarial, attempts were made to convert arylbiguanides into arylcyanoguanidines (important intermediates for biguanide synthesis) by this method. *p*-Chlorophenylbiguanide when reacted in cold with nitrous acid led to the formation of *p*-chlorophenylguanylurea instead of the corresponding substituted cyanoguanidine. While in the case of phenyl and *p*-anisyl-biguanides, acid insoluble (giving picrates) but alkali soluble products have been obtained which are being further investigated. *p*-Nitrophenylbiguanide also behaved like *p*-choloro-phenylbiguanide when treated with nitrus acid under similar conditions. The nature of substituents seems to have an important bearing on the course of reaction, in the case of negative and positive substituents in the phenyl ring of the arylbiguanide.

84. Condensation of methone with anthranilic and substituted anthranilic Acids.

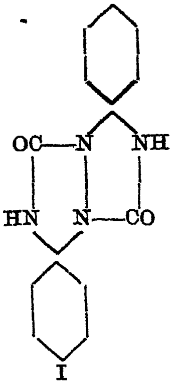
T. S. Sivaswami *and* B. H. Iyer, Bangalore.

Methone has been condensed with anthranilic and N-methyl-, N-phenyl- and 4-methyl anthranilic acids to yield the corresponding N-(3′-keto-5′-dimethyl-3′: 4′: 5′-tetrahydro)-phenyl-anthranilic acids. The products from anthranilic and 4-methyl anthranilic acids have been cyclised by sulphuric acid to the corresponding 1-keto-3-dimethyl 1: 2: 3: 4-tetrahydroacridones. When the reactants were fused together at high temperatures, the same acridones were obtained at one step. Clemmensen reduction of both the acids and acridones has been attempted.

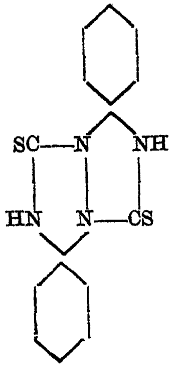
85. Crisscross Addition to Cyclohexanonazine.

D. B. Dutt *and* P. C. Guha, Bangalore.

Bailey and Moore (*J. Amer. Chem. Soc.*, 1917, *39*, 279) and Bailey and McPherson (*ibid*, 1917, *39*, 1322,) found that two molecules of cyanic acid, thiocyanic acid and phenyl isocyanate add to one molecule of benzalazine at the 1,3-positions giving substituted bitriazoles. 'Crisscross addition' was the name suggested to this type of addition. So far Crisscross addition to azines of the type R. CH=N—N=CHR alone has been studied. For the first time the reaction has been extended to ketazines. Cyclohexanonazine has been found to add two molecules of cyanic and thiocyanic acids giving compounds (I) and (II) respectively. Maleic anhydride too adds up very readily to the Ketazine giving a white amorphous product melting at 283°C.



I
m.p. 206°C



II
m.p. 205°C

86. Studies in Antimalarials:—Part I. Some Heterocyclic Substituted Arylbiguanides.

H. L. Bami *and* P. C. Guha, Bangalore.

With the discovery of paludrine (N_1-p chlorophenyl-N_5-isopropylbiguanide), as a potent antimalarial, sufficient interest has been developed in the field of substituted biguanide derivatives in order to discover a better drug. The replacement of p-chlorophenyl part of paludrine with other heterocyclic groups (May *et al.*, *J. Org. Chem.* 1947, 12, 869) has resulted in inactive compounds. Considering the point that p-chlorophenylbiguanide chain is perhaps a basic unit for activity in this type of compounds, various potential substituents were tried at N_5-position of the biguanide chain (Bami, Iyer and Guha; *J. Indian Inst. Sci.*, 1947, *29A*, 15; 1948, *30A*, 1-16; Roy, Iyer and Guha, *Curr. Sci.*, 1948, *7* 126; upta *et al.*, *ibid.*, *53*, 185) of which some have shown encouraging activity.

This work has now been extended by preparing various N_5-p--R-substituted phenyl N_5-2-thiazolyl biguandies (R=H, Cl, Br, Me etc.) obtained by the interaction of p-substituted phenyl-cyanoguanidines with 2-amino-thiazole hydrochloride in alchol. A number of other amino-heterocyclics have also been tried for this reaction without success.

87. Studies in Antimalarials:—Part II. N^1—Aryl-N^5-alkyl-biguanides.

H. L. Bami *and* P. C. Guha, Bangalore.

A number of substituted biguanide derivatives have been prepared in order to find drugs having antimalarial activity better than that of paludrine (Studies in antimalarials part I: these abstracts). In all such cases the biguanide chain has been loaded with various complex molecules and these compoumds have not shown great promise. It was therefore considzred worthwhile to study simpler substituents at the either end of a biguanide chain.

Consequently various isomers and analogues of plaudrine were prepared where the effect of the chlorine atom in the different positions in the phenyl ring, the effect of other halogen atoms and cyano group at the para position of the phenyl ring and the effect of an extra chlorine atom in the p-chlorophenyl group habe been studied. The work has been further extended in which the isopropyl group in N^1-2 :4-dichlorophenyl -N^5- isopropyl-biguanide has been replaced by a number of different alkyl groups.

88. Studies in Antimalarials—Part III. Synthesis of Some 5-substituted Guanidines of 2-chloro-7-methoxy Acridine.

P. C. Guha *and* J. R. Guha, Bangalore.

Atebrin, though claimed to have been superseded by the biguanide derivative Paludrine as an antimalarial, is 2-chloro-5-diethylamino-isopentylamino-7-methoxy acridine. It was considered desirable to prepare a series of 2-chloro-7-methoxy acridine derivatives with guanidino, biguanidino and amidine grouping inserted in position 5. 2-Chloro-5-amino-7-methoxy acridine by the action of thiourea gave the corresponding 5-thiocarbamido derivative. With the object of preparing the corresponding guanidine derivative, the ethyl-thiol compound of the thiocarbamide was treated with ammonia and amines without success.

The second method tried has been successful. It consists in treating the 2-chloro-5-amino-7-methoxy acridine with cyanogen bromide resulting in the formation of the 5-cyanamido acridine compound, m.p. 231°C (I), which on treatment with aniline, *o*- and p-toluidines, *o*- and *p*- anisidines and *p*-chloroaniline have given the corresponding R- substituted guanidine derivatives of 2-chloro-7-methoxy acridine. melting respectively at (i) R=Ph m.p. 178°., (ii) $R=o\text{-}CH_3C_6H_4$ m.p. 204°., (iii) $R=p\text{-}CH_3.\ C_6H_4$ m.p. 180° (iv) $R=o\text{-}OCH_3.C_6H_4$., m.p. 188°., (v) $R=p.OCH_3.C_6H_4$ m.p. 198°., (vi) $R=p\text{-}Cl.C_6H_4$ m.p. 220°.

89. Studies in Antimalarials—Part: IV. Some Quinoline Substituted-biguanides.

P. R. Gupta *and* P. C. Guha, Bangalore.

In the field of synthetic antimalarials, the quinoline compounds are considerd to exert effective parasiticidal activity, With a view to studying the antimalarial activity of quinolyl-biguanides, some new N^1-(8-quinolyl)-N^5-aryl-biguanides and some N^1-(8-chloro-5-quinolyl)-N^5-substituted-biguanides have been prepared.

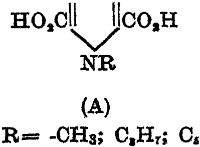
By the action of 8-amino-quinoline hydrochloride on the. corresponding aryl-cyno-gaunidines, eight biguanides with the following substituents have been prepared:- (i) N^1-(8-quinolyl)-N^5-phenyl-, (m.p. 190°C.); (ii) p-tolyl-, (m.p. 190-91); (iii) p-anisyl-, (m.p. 179°C.); (iv) p-NO_2-phenyl-, (m.p. 188-89°C.); (v) p-AcNH-phenyl-, (m.p. 250°C); (vi) p-Cl-phenyl-, (mp. 191-92°C.); (vii) p-Br-phenyl-, (m.p. 204-205°C.) and (viii) p-I-phenyl-, (m.p. 239°C.)

In the second seires, 8-chloro-5-quinolyl-amine hydrochloride was made to react with the appropriate cyanoguanidines giving the following substituted biguanides :- (i) N^1-(8-chloro-5-quinolyl)-N^5-unsubstituted-, (m.p. 213°C.); (ii) phenyl-, (m.p. 198°C.); (iii) p-tolyl-, (m.p. 170-171°C.); (iv) p-anisyl-, (m.p. 210°C.); (v) p-AcNH-Phenyl-, (m.p. 194-96°C.); (vi) p-anilyl-, (m.p. 165-66); (vii) p-NO_2-phenyl-, (m.p. 207°C); (viii) p. Cl-phenyl-, (m.p. 214°C.); (ix) p-Br-phenyl-, (m.p. 210-11); (x) p-I-phenyl-, (m.p. 152°c.) All of the compounds decompose at their melting points.

90. Studies in Antimalarials—Part V. N-Substituted-phenyl Pyridines.

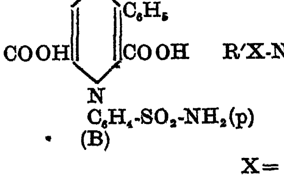
L. Neelakantan, B. H. Iyer *and* P. C. Guha, Bangalore.

Quinine, plasmoquin and atebrin, the well-known antimalarial drugs can be regarded as benzo- or dibenzo- substituted pyridine derivatives. With a view to studying the antimalarial activity of simpler pyridine derivatives, phenyl pyridine derivatives of types (A), (B) and (C) have been prepared by reacting 3-phenyl-1:4-pyrone-2:6-dicarboxylic acid with primary amines, sulphonamides and biguanides, respectively.

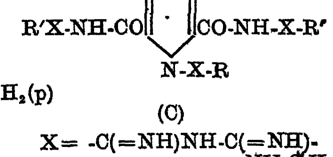


(A)

$R=$ $-CH_3$; C_3H_7; C_5H_{11}; C_6H_5; $Cl.C_6H_4$; $MeO.C_6H_4$; N^4-sulphathiazole; N^4-sulphapyridine; N^4-sulphadiazine, etc.



(B)



(C)

$X=$ $-C(=NH)NH\text{-}C(=NH)\text{-}NH\text{-}C_6H_4$

$R'=$ H; Cl; MeO; Me; NO_2

91. The Optical Rotatory Powers of Quinine Salts.

SUDHAMOY MUKHERJEE, Calcutta.

A study has been made on the dependence of the optical rotation of quinine salts on various factors including concentration, temperature and the presence of various cations and anions. The molecular rotation of different quinine salts is found to vary in the order: bihydrochloride $>$ bisulphate $>$ tartrate (in N/20HCl) $>$ hydrochloride (neutral). It also increases with dilution. Increase of temperature causes a lowering of the rotation.

The molecular rotation of quinine hydrochloride increases with the addition of hydrochloric acid and reaches maximum value when the proportion of acid is 1.25 equivalents corresponding to one molecule of quinine hydrochloride. On adding further quantities of hydrochloric acid the rotation gradually decreases. A similar decrease takes place if sodium chloride is added after the maximum rotation has been reached.

The addition of sodium chloride to neutral quinine hydrochloride solution causes a decrease of the molecular rotation. Sulphuric acid, however, increases the rotation in the same manner as hydrochloric acid.

The addition of different electrolytes, in 2 normal concentration, lowers the molecular rotation of quinine sulphate solution (in N/10 H_2SO_4) in the following order: HCl, NaCl, $MgCl_2 > AlCl_3 > NaNo_3 > (COOH)_2 > Na_2SO_4 > H_3Po_4 > CH_3.\ CO_2Na > H_2SO_4$ $>$citric acid. Acetic acid increases the rotation slightly. A similar marked depressing effect of hydrochloric acid and sodium chloride is also noticed on quinine tartrate solution (in N/20 HCl).

The significance of the results has been discussed.

92. Studies on Sulphonamides and Analogous Compounds:—Part III.

U. P. BASU, Calcutta.

Sulphanilyl benzamide, sulphacetamide, sulphadiazine and sulphamerazine have been condensed with formalin as well as hexamine to afford the corresponding 4-hydroxy methyl derivatives of the sulpha drugs. These compounds are readily soluble in alkali, and liberate formaldehyde on warming. They remain unchanged under the influence of dilute hydrochloric acid (0.36%) even for a period of three hours.

As, for exerting the chemotherapeutic action, a sulpha drug must be present in the anionic form at the site of infection, these compounds might be expected to be effective against intestinal infections. As a matter of fact the hydroxymethyl amino benzene sulphon benzamide is being reported to exert even a bactericidal action again *v. cholerae* in very small concentration *in vitro.*

93. On the Chemistry of "6257"- A Sulpha Compound Active against V. Choleræ.

U. P. BASU, Calcutta.

Recently a compound of the empirical formula $C_{21}H_{22}O_6N_6S_4$ has been found (Bhatnagar, *Brit. Med. Jour.* 1948, *i*, 719) to be effective against human Cholera infection. It was obtained by the interaction of 2 molecules of sulphathiazole with 3 molecules of formalin in the laboratories of Ciba at Switzerland, but no constitution has been ascribed to the compound.

Working in this direction it is being noticed that the coumpound may also be obtained by reacting sdlphathiazole with hexamin. From a study of its characteristics and from other allied reactions it seems to be a compound where both the mobile hydrogen atoms in sulphathiazole have been replaced by interaction with formaldehyde. As the parent compound exists in two forms (*cf.* Shepherd, *Jour. Amer. Chem. Soc.*, 1942, *64*, 2532), the present condensation product may be methylene N, N′-*bis*-(4-hydroxymethyl-2-sulphanilamido-thiazole), or, methylene-3, 3′-*bis*- (4-hydroxyymethyl-2-sulphanilimido -2, 3-dihydrothiazole), or, both. But the non-solubility of the compound suggests the latter structure.

94. Hydrolysis of Sulphonamides by Sulphuric Acid.

D. D. KARVE, K. K. DOLE, *and* R. D. SONATAKKE, Poona.

Hydrolysis of the aromatic sulphonamides has been carried out at different temperatures and with different concentrations of the catalysing acid. The sulphonamides investigated include :—

1) Benzene Sulphonamide
2) p-amino benzene sulphonamide
3) p-toluene sulphonamide.

Out of these, p-amino benzene sulphonamide was investigated in detail. Its study showed that at moderately high temperatures (120° to 150°C) the hydrolysis proceeded at a measureable rate and followed unimolecular law fairly accurately. An increase in the concentration of the catalyser (20 N to 30 N), and an increase in the temperature of the reaction (120° to 150°C) favours the reaction with a temperature co-efficient of about 2.5.

The hydrolysis of p-toluene sulphonamide proceeded at a rate faster than that for p-amino-benzene sulphonamide. Benzene sulphonamide hydrolysed still faster. Thus the order of decreasing reactivity was found to be benzene sulphonamide, p-toluene-sulphonamide and p-amino-benzene-sulphonamide.

p-Carboxy benzene sulphonamide was not investigated since it was found to be insoluble in sulphuric acid.

Further work is in progress with the detailed investigation of p-amino benzene sulphonamide and p-toluene-sulphonamide at different temperatures and using different concentrations of the catalyser.

95. Condensation of 2:4:6-Trichloro-, 2:4:6:Tribromo- and 2:4:6-Tri-Iodo-3-Hydroxybenzaldehydes with Malonic Acid.

KANTILAL C. PANDYA *and* RAGHU NATH SINGH, Agra.

Lock and Bayer (1939) have shown that in Perkin's Reaction chlorine exerts a helpful influence to a certain extent. Pandya and Miss Pandya (1941) also pointed out that in the aldehyde-malonic acid condensations, catalysed by pyridine, the presence of a chlorine atom, and even more, that of a bromine atom, on the aromatic ring of the aldehyde, has a most striking effect finishing up the reaction in some cases in only 1.5 hours with a quantitative yield. Iodine has also been found to have a similar effect.

m-Hydroxybenzaldehyde has been found, in these condensations, to give a quantitative yield of *m*-coumaric acid. When the aldehyde contains on the ring three chlorine or three bromine or three iodine atoms, a further increase in the yield is therefore impossible, but the acceleration in the speed of the reaction becomes obvious.

The three tri-halogenated aldehydes give a nearly theoretical yield of the dibasic acids, the 2: 4: 6-trihalogenated-3-hydroxybenzylidene-malonic acids. *m*-Hydroxy-benzaldehyde has only recently (1948) given in the hands of Pandya and Miss Rajani Bala Pandya about 25% of the *m*-hydroxybenzylidenemalonic acid, earlier workers not having succeeded in isolating it. When compared to this 25%, the almost theoretical yield from the three tri-halogenated aldehydes, is a great improvement. It appears that the halogen, particularly chlorine, gives greater stability to the dibasic acid.

96. Condensation of 4-Bromo- and 6-Iodo-3-Hydroxybenzaldehyde and of *m*-Hydroxybenzaldehyde with Malonic acid.

KANTILAL C. PANDYA *and* MISS RAJANI BALA K. PANDYA, Agra.

Pandya and Miss Rajani Bala Pandya and later Pandya and Raghu Nath Singh have shown the effect of the halogen in the aldehyde-malonic acid condensations. The present work also bears on it.

m-Hydroxybenzaldehye gave a quantitative yield of *m*-coumaric acid in the above condensation (Pandya and Vahidy, 1936). The same yield has now been obtained at water-bath temperature in the presence of pyridine acetate. By following Stuart's method for the first time *m*-hydroxybenzylidenemalonic acid, m.p. 150-151° has been isolated in 25% yield.

4-Bromo-3-hydroxybenzaldehyde gave both the acids, the 4-bromo-3-hydroxycinnamic and the 4-bromo-3-hydroxy-benzylidenemalonic acids, the former in about theoretical yield and the latter in about 42% yield.

6-Iodo-3-hydroxybenzaldehyde condensed very fast. Only 2.5 hours' heating was sufficient to give a 94% yield of the 6-iodo-3-hydroxycinnamic acid. The corresponding dibasic acid has not yet been obtained. The presence of iodine makes the aldehyde as well as the acid somewhat unstable at high temperatures.

97. Condensation of Aldehydes with Ethyl Acetoacetate in the Presence of Organic Bases.

DEVBRAT DUTT, SOMENDRA NATH GUPTA *and* KANTILAL C. PANDYA, Agra.

The condensation of aldehydes with acetoacetic ester in the presence of piperidine and other bases has been extensively studied by Knoevenagel almost half a century back. The powerful catalytic effect of 1/6th of a molecule of pyridine in malonic acid-aldehyde condensations has been pointed out by the work in this Laboratory since 1932. An attempt has been made to find out if the reactivity of the methylene group in acetoacetic ester is also similarly catalysed by pyridine. About nine different aldehydes have been condensed with this ester in the presence of piperidine *or* pyridine under different conditions of temperature, time and molecular proportions.

Pyridine has been found to be a successful condensing agent in this reaction also. Because it is a weaker base than piperidine, it has to be used in larger molecular proportion (6 molecules for one of aldehyde), and waterbath or similar temperatures can be used, and are necessary to quicken the condensation. It did not often form resin and generally gave the monoacetoacetate product in a very pure form. Conditions have been worked out to get the *bis*-acetoacetate by using piperidine in a few drops. The yields, when pyridine is used, are often good, though generally they are less than those obtained when piperidine is used. Some of the condensation-products are probably new. The reactivity of the methylene group is here—as in aldehyde-malonic acid condensations—very much affected by the other groups present in the aldehyde molecule.

98. Friedel-Crafts Reaction in Hydroxyquinolines.

V. M. THAKOR *and* R. C. SHAH, Bombay.

In continuation of the work already reported (Indian Science Congress Abstracts, 1947), Friedel-Crafts reactions have been carried out on 4-hydroxy-2-methylquinoline, when with acetic anhydride and acetyl chloride 4-hydroxy-2-methyl-3-acetylquinoline and with benzoyl chloride 4-hydroxy-2-methyl-3-benzoylquinoline were obtained. This is the first instance of Friedel-Crafts reaction in hydroxyquinolines with the hydroxy group in pyridine rings.

All attempts to carry out Friedel-Crafts reaction with 2-hydroxy-4-methylquinoline were unsuccessful showing the feeble reactivity of 3-position in 2-hydroxyquinoline derivatives. This was confirmed, as attempts to couple the quinoline with benzenediazonium chloride were also unsuccessful.

99. Azo Dyes from Diphenyl-p-aminobenzamidine.

K. R. BHARUCHA *and* R. C. SHAH, Bombay.

A number of azo dyes from diphenyl-*p*-aminobenzamidine—which is readily obtainable by the method of Shah (*J. Ind. Inst. Sc.*, 1924, *7*, 205) from aniline and carbon tetrachloride—have been prepared by coupling its diazonium chloride with phenol, salicylic acid, β-naphthol, β-naphthylamine and 2-hydroxy-3-naphthoic acid. With a view to obtain some Azoic or Ice colours, couplings were carried out with different Brenthols like Brenthol OT, Brenthol CT, Brenthol PA, Brenthol AS, Brenthol BN and Brenthol AT. Couplings have also been brought about with some naphthol- and naphthylamine-sulphonic acids including G acid, R acid, Schaffer's acid, Branner's acid and Naphthionic acid.

100. Some Reactions of Diphenyl-p-aminobenzamidine.

K. R. Bharucha *and* R. C. Shah, Bombay.

Diphenyl-*p*-aminobenzamidine was diazotised and subjected to various reactions whereby the NH_2 group in benzamidine was replaced by different radicals such as Cl, Br, I, and OH giving rise to a number of derivatives of diphenylbenzamidine with substituents in the para position. These benzamidines have also been obtained from the corresponding *p*-chloro-, *p*-bromo-, and *p*-iodo-benzoic acids through their anilides by the method of Sidiki and Shah (*J. Univ.* Bombay, 1937, *6A*, 132). Diphenyl-*p*-cyanobenzamidine could not be obtained from diphenyl-*p* aminobenzamidine and was synthesised from *p*-cyanobenzoic acid through its anilide in the above manner. Sulphonation, bromination and nitration of the base have also been carried out but it was only in the case of sulphonation and nitration that pure products could be isolated.

101. Condensation of Benzanilide Imidochloride with Phenols: A new Synthesis of Hydroxybenzophenones.

(Miss) Ragini Phadke *and* R. C. Shah, Bombay.

Benzanilide imidochloride has been condensed with resorcinol, phloroglucinol, ∝- and *β*-naphthols using anhydrous aluminium chloride as the condensing agent. The resulting products which are keto-anils have subsequently been hydrolysed to the corresponding hydroxy-benzophenones, and hydroxy-naphthyl-phenyl ketones. Resorcinol dimethyl ether has also been condensed with benzanilide imidochloride to give the corresponding keto-anil. This provides a new synthesis of hydroxybenzophenones. Work is in progress on similar condensations with phenol, anisole, resorcinol monomethyl ether and other phenols.

102. Substitution in the Orcinol Nucleus.

P. R. Saraiya *and* R. C. Shah, Bombay.

The Fries Transformation of the diacetate of methyl *o*-orsellinate under differen conditions gave methyl 2-acetyl-*o*-orsellinate and methyl 2:4-diacetyl-*o*-orsellinatet From the diacetate of ethyl *o*-orsellinate ethyl 2-acetyl-*o*-orsellinate, ethyl 2:4-diacetyl-*o*-orsellinate, and 2:4-diacetyl-*o*-orsellinic acid were obtained in a similar manner.

With the exception of 2:4-diacetyl-*o*-orsellinic acid, the same compounds were also produced by the Friedel-Craft acetylation of methyl and ethyl *o*-orsellinates with acetyl chloride or acetic anhydride.

The Fries Transformation of the diacetates of methyl and ethyl *p*-orsellinates as well as the Friedel-Craft acetylation of methyl and ethyl *p*-orsellinates gave only 4-acetyl-*p*-orsellinic acid, which was decarboxylated to *β*-orcacetophenone by heating with copper-bronze and quinoline.

103. Substitution in Resorcinol Nucleus.

C. S. Mody *and* R. C. Shah, Bombay.

It has been found that in case of orcinol. substitution takes place in γ-position in many cases, unlike resorcinol where γ-substitution is rare. No explanation is available so far for this anomalous behaviour of orcinol. In order to obtain some further data on the subject some reactions have been carried out on methyl ester of ∝-resorcylic acid or 5-carboxyresorcinol.

When Gattermann's reaction was carried out on methyl ∝-resorcylate, substitution took place in *β*-position and methyl 3:5-dihydroxy-2-formylbenzoate was obtained.

In Fries and Friedel-Crafts reaction on methyl ∝-resorcylate no pure product could be isolated.

Pechmann reaction on methyl ∝-resorcylate with acetoacetic ester in presence of sulphuric acid gave methyl 7-hydroxy-2-methyl-chromone-5-carboxylate, 7-hydroxy-2-methylchromone-5-carboxylic acid and methyl 5-hydroxy-4-methylcoumarin-7-

carboxylate. On Pechmann reaction with ∝-resorcylic acid, only 7-hydroxy-2-methylchromone-5-carboxylic acid was obtained. This is one of the rare cases where chromones are obtained in Pechmann condensation, using sulphuric acid as a condensing agent.

Methyl ∝-resorcylate when condensed with malic acid however, gave 7-hydroxycoumarin-5-carboxylic acid and little of its methyl ester.

104. Nuclear Benzylation of Polyhydroxy Ketones.

B. Z. MULLAJI *and* R. C. SHAH, Bombay.

Nuclear alkylation of hydroxy aromatic compounds has been studied by various workers (Herzing and Zeisel, *Monatsh*, 1888, 1889 & 1890; Perkin, *J. Chem. Soc.*, 1895; Robinson and Shah, *ibid.*, 1934; Shah and Samant, *Proc. Ind. Acad. Sci.*, 1938). But no work has been reported on nuclear benzylation of hydroxy aromatic compounds.

Nuclear benzylation of hydroxy ketones was carried out with benzyl chloride. It was found that resacetophenone, respropiophenone, resbutyrophenone and resbenzophenone are comparatively easily nuclearly benzylated giving 3–benzyl derivatives. The same ketonic derivatives have been obtained by the Hoesch reaction on 2–benzyl resorcinol with the corresponding nitrites. This is of interest since nuclear ethylation takes place with more difficulty than methylation, but even though the benzyl radical is a heavier one, benzylation is more facile.

105. Action of Chlorosulphonic Acid on Coumarins.

J. R. MERCHANT *and* R. C. SHAH, Bombay.

No work appears to have been done on the action of chlorosulphonic acid on coumarins. Action of chlorosulphonic acid has now been studied on simple coumarin and 6–nitrocoumarin under different conditions when coumarin–6–sulphonic acid, coumarin 3:6–disulphonic acid, 6–nitrocoumarin–3–sulphonic acid and their chlorides are obtained. The action of chlorosulphonic acid on a number of 7–hydroxycoumarin derivatives has been studied. The products have been found to be mono–, di–, or tri-sulphonic acids and sometimes the sulphonyl chlorides. The sulphonic acids are isolated as their sodium or barium salts and are characterised by the formation of derivatives with S–benzyl thiuronium hydrochloride. The constitution of the sulphonic acids and the sulphonyl chlorides obtained have been established.

The work is being extended in the 5–hydroxy–4–methylcoumarin series.

106. Action of Chlorosulphonic Acid on Chromones.

J. R. MERCHANT *and* R. C. SHAH, Bombay.

No work appears to have been done on the action of chlorosulphonic acid on chromones. The action of chlorosulphonic acid has now been studied on 7–hydroxy– and 5–hydroxy–2–methylchromones and their methyl ethers. The products which are sulphonic acids have been isolated in the form of their sodium or barium salts and are characterised by the formation of derivatives with S–benzyl thiuronium hydrochloride. The constitution of some of the sulphonic acids have been established.

107. Condensation of ∝ : ∝ : β–trichloro–*n*–butyraldehyde with Benzene and Naphthalene Derivatives.

(MISS) L. H. DALAL *and* R. C. SHAH, Bombay

In continuation of the work reported last year (Indian Science Congress Abstracts 1948, 35) ∝: ∝: β–trichloro-*n*-butyraldehyde has been condensed with phenol when the compound of the structure ∝: ∝–*bis*–(*p*-hydroxyphenyl)– β: β: γ–trichloro-*n*-butane was obtained. Similar compounds have been obtained in case of toluene and ∝– and β–chloronaphthalenes. Their structures have been proved by dehydrohalogenation and subsequent oxidation to their corresponding known benzophenones and dinaphthyl ketones.

The work on similar condensations with other derivatives is in progress.

108. Halogenation. Chlorination, Bromination, Iodination and Nitration of o–and p–Hydroxy diphenyls and their ethers.

P. S. Varma, *and* B. C. Lal Agarwal

By chlorination 3:5–dichloro–2–hydroxy diphenyl m.p. 256–258°, 3–chloro-4–hydroxy diphenyl, m.p. 75°, 5–chloro 2–methoxy diphenyl, m.p. 68°, 3:5–dichloro–2–methoxy diphenyl, m.p. 52°, 4–chloro–4–methoxy diphenyl, m.p. 92° ; 3:4–dichloro-4–methoxy diphenyl, m.p. 42° ; by bromination 5–bromo-2–methoxy diphenyl, b.p. 260–261°, 3:5–dibromo—methoxy diphenyl, 3–bromo–4–methoxy diphenyl m.p. 79°, 4–bromo–4–methoxy diphenyl, m.p. 144° ; by iodination 3:5:4–triodo–4–hydroxy diphenyl, m.p. 102° and by nitration 5–nitro–4–methoxy diphenyl, m.p. 95–96°, 3–nitro–4–methoxy diphenyl, 3:4–dinitro 4–methoxy diphenyl, m.p. 171° have been prepared and their constitution established.

109. Halogenation. Part XLIII. Iodination.

P. S. Varma, K. S. Venkat Raman *and* U. N. Narayan Rao, Banaras.

o–Chloro–nitrobenzene, m–bromo–nitrobenzene, anisole, phenetole, 0–nitrophenetole, p–bromo-anisole and p-bromophenetole have been iodinated under different conditions by methods worked out in our Laboratory and the following compounds have been obtained :— 5 Bromo–2–iodo–1–nitrobenzene, 5–iodo–2–chloro–1–nitrobenzene, 2–nitro–4–iodophenetole, 2–iodo–4–nitrophenetole, 2–nitro–4–iodoanisole, 4–nitro–2–iodo anisole and iodo-nitro derivatives of p-bromoanisole and p–bromophenetole.

110. Synthesis of Some New Organo-metallic Compounds of Selenium.

P. S. Varma, K. S. Venkat Raman *and* P. V. G. Krishnamacharyulu,
Banaras.

Selenium oxy-chloride has been condensed with (1) dimethyl aniline ,(2) diethyl aniline, (3) methyl ethyl aniline, (4) methyl benzyl aniline, (5) ethyl benzyl aniline, (6) dibenzyl aniline, (7) dimethyl p–toluidine, (8) dimethyl α–naphthyl amine, (9) ethyl benzyl–o–toluidine and (10) methyl diphenyl amine and well-defined crystals of their condensation products have been obtained and their properties studied.

111. Synthesis of four Isomeric Methyl Derivatives of 7–chloro–7 : 12–dihydro– and 12–chloro–7 : 12–dihydro–benzo–phenarsazines and 2–benzoyl–10–chloro–5 : 10–dihydro–phenarsazine.

P. S. Varma, K. S. Venkat Raman *and* T. P. Visvanathan, Banaras.

o–Tolyl– α–naphthyl amine, o–tolyl– β–naphthyl amine, m–tolyl–α–naphthyl amine, m–tolyl– β–naphthyl amine and phenyl p–amino benzophenone have been condensed with arsenic trichloride dissolved in o–dichlorobenzene and the condensed products, four isomeric methyl derivatives and the benzyl derivative of benzophenarsazine so obtained have been oxidised to the corresponding arsenic acids and their ethoxy and phenoxy derivatives studied.

112. Studies in Sulphur, Selenium and Tellurium Compounds. Preparation and properties of Phenothionine, Phenox-selenine and Phenoxtellurine.

P. S. Varma, K. S. Venkat Raman *and* (Miss) Indu D. Bokil, Banaras.

Phenoxthionine, m.p. 58°, phenoxselenine, m.p. 88°, phenoxtellurine, m.p. 79° have been prepared and their properties studied. Phenoxthionine yields an oxide m.p. 158–159° and a dioxide, m.p. 147–148° and does not form a dichloride, dibromide or diacetate. Phenoxselenine forms an oxide, a dihydroxide, a stable dichloride and an unstable acetate. Phenoxtellurine yields similar derivatives.

113. Mercuration of Amines.

P. S. VARMA, K. S. VENKT RAMAN *and* (MISS) INDU D. BOKIL, Banaras.

The mercury derivaties of methyl benzyl aniline and methyl ethyl aniline have been prepared either by the action of mercuric acetate in an alcoholic solution of the base or by dissolving yellow mercuric oxide in an aqueous solution of the acetate of the amine. The mercuric acetate derivative so obtained has been converted into the hydroxide, the chloride, bromide, iodide and nitrate in almost quantitative yields. The diaryl mercury derivatives have also been obtained.

114. Crystalline Components of the Bark of Prunus Puddum.

D. CHAKRAVARTI, Calcutta.

The glucoside sakuranin (m.p. 213–214°) has been isolated from the immature bark of *Prunus Puddum*, while not a trace of the previously described components of the mature bark *e.g.* Puddumetin, Prunusetin, Sakuranetin have been obtained. The glucoside on hydrolysis furnishes the flavanone Sakuranetin ($C_6 H_{14} O_5$) m.p. 150–151°, methyl ether, m.p. 116–117°, oxime, m.p. 201–203°.

115. A New Process for the Manufacture of Ephedrine Hydrochloride from the Ephedras.

S. K. SAHA, Calcutta.

A direct and economic method has been developed for the extraction of Ephedrine Hydrochloride from the ephedras. Finely powdered drug is thoroughly mixed with straw, lime and water and extracted with solvent benzol in a specially designed apparatus in which the solvent circulates in continuous cycle first through the drug, then into dilute hydrochloric acid and then through a reservoir into drug again until extraction is complete. Ephedrine hydrochloride is directly obtained by concentrating the acid solution. The yield is almost theoretical.

116. Dipole Moment of Fatty Acids.

S. K. K. JATKAR *and* (MISS) S. B. KULKARNI, Bangalore.

In continuation of the previous work on the dipole moment of fatty acids like capric, stearic etc., the dipole moments of the homologous series of fatty acids in pure liquid state as well as in different solvents have been calculated by applying the new relationship. The results show that in liquid state the acids are associated to dimers, which dissociate into monomers at higher temperatures. The moments calculated from the data in solutions like benzene, indicates that the moments increase with concentration. Hence the planar model for dimer proposed by Pauling and Brockway does not hold good. In addition to the Skew (boat) model proposed by Paranjpe for the dimer, one more chair model, which has zero moment, has been proposed by the present authors. The increase of dipole moment of acids in benzene with concentration has been explained as due to the change in the percentage mixture of boat and chair form of the dimers, the boat form having a moment of 1.4 and the chair form a zero moment. *The increase* in dipole moment of the pure acids at higher temperature is due to the dissociation of the dimers. The apparent moment calculated from dioxane and ether also indicates that in these solvents the acids are partially associated, the moments at zero concentration corresponding to the free rotation value of the monomer.

117. Dipole Moments of Diketene, Benzoic Anhydride & Benzoyl Peroxide.

S. K. K. JATKAR *and* R. J. SUJIR, Bangalore.

The new equation has been employed to calculatee the dipole moments of diketene, benzoic anhydride and benzoyl peroxide. The results are interpreted on the basis of component law.

118. Side Chain Chlorination of Aromatic Copmpounds in the Vapour Phase—Part II.

G. V. Asolkar, Nagpur.

In continuation of author's previous work (*Proc. Ind. Sci. Cong.* 1945 and *J. Ind. Chem. Soc.* Vol. XXIII, *No. 2* 1946, 47–52) it was deemed necessary to investigate the chlorinations of some aromatic nitro compounds in the vapour phase. It was previously pointed out (*loc. cit*) that the chlorination of the meta and para nitrotoluenes are negative in the vapour phase inspite of the prolonged chlorination.

By modifying the experimental condition *viz.*,using sulphur (*cf.* Haenssermann and Beck, *Ber.* 1892, *25*, 2445—Chlorination in the liquid state), and using ultraviolet light it is found that the vapour phase chlorination of the nitrotoluenes (–m and–p) does take place, The yields of the side chain products are poor, and other nuclear substitution products are produced rondering the separation of the products difficult. The results are still negative for o–nitrotoluene, even under these modified conditions. The vapour phase chlorinations of such nitro compounds as nitrobenzene, o, m, p–nitrobenzaldehydes are in progress.

The vapour phase chlorinations of some essential oils like the Palm Rosa oil (Rusa Grass oil), oil of Calamars, Citronellol, Geraniol have also been carried out.

119. Chalkones from Respropiophenone and its Monomethyl Ether.

P. B. Mahajani *and* Suresh Sethna, Bombay.

Respropiophenone and its monomethyl ether have been condensed with benzaldehyde and the products obtained shown to be 2:4 dihydroxyphenyl–α–methylstyryl ketone and 2–hydroxy–4–methoxyphenyl–α–methyl styryl ketone respectively. On methylation both gave the same dimethyl ether.

Similar condensation of respropiophenone and its monomethyl ether with *p*-anisaldehyde gave 2; 4-dihydroxy phenyl-α-methyl-4′-methoxystyryl ketone and 2-hydroxy-4:4′-dimethoxyphenyl -α-methylstyryl ketone respectively. On methylation both gave the same trimethyl ether.

The hydroxy chalkones have been converted into the corresponding flavanones by the action of dilute alkali and into the corresponding flavones by heating with selenium dioxide.

120. Bromination of 6–Hydroxy–4–methylcoumarin and its Methyl Ether.

V. J. Dalvi *and* Suresh Sethna, Bombay.

6-Hydroxy-4-methylcoumarin has been brominated with one molecule, two molecules, and excess of bromine. The products obtained have been methylated and the methyl ethers thus obtained have been compared with the products obtained by brominating 6-methoxy-4-methylcoumarin with one molecule, two molecules and excess of bromine. The bromo derivatives from the methyl ether on hydrolysis with boiling alkali have yielded coumarilic acid derivatives.

121. Organic Fungicides I: Synthesis of Dibromacetamides.

A. B. Sen *and* K. C. Joshi, Lucknow.

The present work has been undertaken to study the modifications in fungicidal activity by increasing the number of halogen atoms. Six new dibromacetamides have been prepared preliminary to evaluation of their fungicidal activity.

The starting material, dibromacetic acid, has been obtained by the decarboxylation of dibromomalonic acid. The dibromacetic acid has been converted into dibromacetyl chloride by the action of thionyl chloride and the dibromacetamides obtained by the action of different amines on the dibromacetyl chloride in ether medium.

The following new compounds have been obtained.

Name of Compound	m.p.
1. N-methyl-dibromacetamide	122°C
2. N-ethyl-dibromacetamide	81°C
3. N-*n* butyl-dibromacetamide	76°C
4. N-diethyl-dibromacetamide	212°C
5. N-dibromacetanilide	138°C
6. N-dibromacetyl-phenyl-hydrazine	Does not melt.

122. Studies in the Fries Rearrangement—Part IV.

A. B. Sen *and* V. S. Misra.

The Fries Rearrangement has been extended to several esters of Sorbic acid. The following four esters were prepared which rearranged themselves into the corresponding ortho hydroxyketones, which were characterised as usual through their 2:4-dinitrophenylhydrazones:

Esters :

	b.p.°C/mm.
1. Phenyl ester	141/2
2. o-cresyl ester	143/4
3. m-cresyl ester	180/17
4. p-cresyl ester	m.p.73-74°C

Ketones :

1. 2′-hydroxyphenyl-Δ^9-Δ^4-hexadiene-one-1	83/3
2. 2′-hydroxy-6′-methylphenyl-Δ^2-Δ^4-hexadiene-one-1	103/1
3. 2′-hydroxy-3′-methylphenyl-Δ^2-Δ^4-hexadinene-one-1	122/17
4. 2′-hydroxy-4′-methylphenyl-Δ^2-Δ^4-hexadiene-one-1	150/10

123. Action of Phosphorous Pentachloride on Grignard Complexes.

A. B. Sen *and* G. S. Sidhu, Lucknow.

Aldehydes and ketones react with Grignard reagents to form complexes which on hydrolysis give alcohols. If halogen compounds are required, it is the usual practice to replace the hydroxy group in these alcohols by the use of some suitable reagent like phosphorous halides or thionyl chloride. The present authors have devised a method which saves one step in the preparation of such halogen compounds. The Grignard complex with the carbonyl compound instead of being hydrolysed to the alcohol is direclty reacted with phosphorous pentachloride in dry ethereal suspension. After a few hours refluxing the complex is decomposed in the usual manner by just sufficient ice-cold dilute HCl and yields the halogen compound directly.

Diphenyl-chlormethane has thus been obtained from benzaldehyde, phenyl magnesium bromide and PCl_5, and 1-chloro-1, 1-diphenylethane (b.p.115-6/2mm) from phenyl magnesium bromide, acetophenone and PCl_5..

124. Quinazoline Derivatives—Part I.

A. B. Sen *and* G. S. Sidhu, Lucknow.

Very few quinazolol derivatives are described in literature. The present authors were interested in such compounds with a view to study the effect of the quinazoline ring on analgesic activity and have synthesised the following 4-quinazolols by the action of different Grignard reagents on 2-methyl-3-phenyl-4-quinazolone:-

I 2-methyl-3, 4-diphenyl-4-quinazolol

II 2-methyl-3-phenyl-4-*n*-propyl-4-quinazolol

III 2-methyl-3-phenyl-4-*n*-butyl-4-quinazolol

125. Synthesis of Substituted Dinitro Phenylketones and Phenylacetic Acids—Part III.

A. B. Sen *and* P. M. Bhargava, Lucknow.

2:4-Dinitro 6-iodophenylacetone, m.p. 110°, and 2:4-dinitro 6-iodophenylacetic acid (which does not melt, but decomposes on strong heating) have been prepared by the ketonic and acid hydrolysis respectively, of 2:4-dinitro 6-iodophenylacetoacetic ester, m.p. 74°, which has been obtained by the condensation of monosodium derivative of acetoacetic ester with 1-chloro 2:4-dinitro 6-iodobenzene. The ketone yields a phenylhydrazone, m.p. 74°, and an *oxime*, m.p. 75°. 2-Methyl 3-ethylcarboxy 5-iodo 7-aminoindole, m.p. 135°, has been obtained by the reduction of the above mentioned ester with iron powder and water.

126. Synthesis of Substituted Dinitro Phenylketones and Phenylacetic Acids—Part IV.

A. B. Sen *and* P. M. Bhargava, Lucknow.

2:4-Dinitro 6-chlorophenylacetoacetic ester, m.p. 64°, has been obtained by the condensation of 1:6-dichloro 2:4-dinitrobenzene with sodium derivative of acetoacetic ester. Ketonic and acid hydrolysis respectively, of the dinitrochlorophenylacetoacetic ester, results in the formation of 2:4-dinitro 6-chlorophenyl acetone, m.p. 99°, and 2:4-dinitro 6-chlorophenylacetic acid, which does not melt. The ketone a gives a *phenylhydrazone* m.p. 120°, and an *oxime*, m.p. 95°. The reduction of the above mentioned ester yields 2-methyl 3-ethylcarboxy 5-chloro 7-aminoindole, m.p. 126-27°.

127. Synthesis of Substituted Dinitro Phenylketones and Phenylacetic Acids—Part V.

A. B. Sen *and* P. M. Bhargava, Lucknow.

Condensation of sodium derivatives of acetoacetic and malonic esters with 1:3-dinitro 2:5-dichlorobenzene yields 2:6-dinitro 4-chlorophenylacetoacetic ester (I), m.p. 81°, and 2:6- dinitro 4-chlorophenylmalonic ester, m.p.85°, respectively. The ketonic and acid hydrolysis respectively of (I) results in the formation of 2:6-dinitro 4-chlorophenyl acetone, m.p.122-23°, and 2:6-dintro 4-chlorophenylacetic acid, which dose not melt. The ketone gives a *phenylhydrazone*, m.p. 117-18°, and an *oxime*, m.p.111°. 2-Methyl-3-ethylcarboxy-5-amino-7-chloroindole (m.p. 217°) has been obtained by the reduction of (I) by iron powder and water.

128. Synthesis of substituted Dinitro Phenylketones and Phenylacetic Acids—Part VI.

A. B. Sen *and* P. M. Bhargava, Lucknow.

The following new compounds have been obtained in very good yields:-

2:6-dinitro 4-iodophenylacetoacetic ester, m.p. 113-14°-by condensation of 1-cholro 4-iodo 2:6-dinitrobenzene with sodium derivative of acetoacetic ester,

2:6-dinitro 4-iodophenylacetone, m.p. 138-39°-by ketonic hydrolysis of the above mentioned ester; gives a phenylhydrazone,m.p. 140-142°,

2:6-dinitro 4-iodophenylacetic acid (which does not melt)-by acid hydrolysis of the ester mentioned above and,

2-methyl 3-ethylcarboxy 5-amino 7-iodoindole, m.p. 194-95°-by reduction of 2:6-dintro 4-iodophenylacetoacetic ester by iron powder and water.

129. Insecticidal Properties of Hexachlorocyclohexanes, DDT and Related Compounds.

S. K. K. Jatkar *and* (Miss) S. B. Kulkarni, Bangalore.

The law of unimolecular reaction $K=\frac{2.3}{t}\log\frac{100}{100-x}$ is employed to calculate the mortality coefficients of the various insecticides like hexachlorocyclohexane, DDT etc., from the data on the percentage mortality (x) of the insects killed in certain time (t) and it has been shown that the mortality coefficient K is independent of concentration and time. The r isomer (m.p. 112.5°C) is the most toxic compound being *240 times* as effective as α *and 840* times *as effective as* δ isomer towards mosquito larvas. Of the DDT isomers p, p'DDT is 7 to 10 times as toxic as m,p'-and o,p'-isomers. The compound TDE possesses equal toxicity as p,p' DDT. Comparison of the toxicity of Gammexane, DDT and cuprous cyanide to mosquito larvae of yellow fever, shows that Gammexane is 1.5 times as effective as p,p'DDT, cuprous cyanide being nearly twice as effective as r isomer in dilute solutions. The correlation between the electric moments and the mortality coefficient, indicates that in hexachlorocyclohexane isomers the logarithm of the mortality coefficient is directly proportional to the moment which is the other way round in DDT isomers.

130. Hydrolysis of Amides by Mineral Acids.

V. V. WAKADE, G. G. MUJUMDAR *and* D. D. KARVE, Poona.

The hydrolysis of acetamide has been investigated at 50°C in three different solvents (water, ethyl alchol and acetic acid) using different concentrations of sulphuric acid as the catalyser.

The results clearly show that the tendency of attaining the maximum velocity of hydrolysis at some optimum concentration of the catalyser is common to all the three solvents investigated.

Previous investigators have observed that the optimum concentration of the catalyser for the best hydrolysis of the amide depends upon the nature of the amide and also upon the catalysing acid. The present investigation clearly shows that the optimum concentration of the same catalyser is dependent on the solvent also.

The rate of hydrolysis changes in the order

Water > Alcohol > Acetic acid.

The investigation of the hydrolysis of o-,m-and p-substituted benzamides and also the hydrolysis of acetonitrile under different conditions is in progress.

131. Direct Replacement of (OMgBr) Group by Halogen in the Grignard Complex.

A. B. SEN *and* M. P. UPADHYAYA, Lucknow.

An attempt was made to directly replace the (OMgBr) group in the Grignard complex by halogens. It has been found that partial replacement takes place with fuming and alcoholic hydrochloric acid, hydrobromic acid, sulphuryl chloride and phosphorus trichloride.

The Grignard reagent prepared in the usual way was treated with a ketone and the halogenating agent directly added to the ethereal solution. The mixture was extracted with ether, ether removed and the chloro or bromo compounds separated by fractional distillation under reduced pressure. The compounds prepared were phenyl-methyl-propyl-chloromethane, cyclohexyl-propyl-bromomethane and dimethyl-phenyl-chloromethane.

132. Formylation of methyl–m–hydroxy and p–hydroxy benzoates with hexamethylene tetramine.

(Mrs.) RADHA PANT, Allahabad.

Duff and Bills (J. 1932, 1987) successfully formylated salicylic acid by heating it with hexamethylene tetramine but when they treated meta-and para-hydroxy benzoic acids under the same conditions, complex amorphous products were obtained. Desai and Radha (Proc. Ind. Acad. Sci. 1940, XI A, 422) and Shah, Radha and Desai (Proc. Ind. Acad. Sci. Vol. XXIII, 1946)found that the methyl esters of various phenolic acids could be formylated easily by this method- Methyl esters of *m*-and *p*-hydroxy-benzoic acids have therefore been subjected to the action of hexamethylene tetramine and the formyl esters obtained. The phenyl hydrazones and other derivatives of these esters have been prepared. The consitutions of these formyl esters are being studied.

133. Determination of Unsaturation in Oils and Soaps by Means of Hypochlorous Acid.

S. K. Basu *and* M. Goswami.

In the previous paper on the subject (Analyst, 1934,59, 533; J. Indian Chem. Soc. 1934, 11, 905) it had been shown by one of us the feasibility of determination of unsaturation in oils with hypochlorous acid and practical advantages over the prevalent methods e.g. Wiji, Hanus. There were some practical difficulties connected with the use of the said acid and the object of the paper has been to remove those so that it can be very easily adapted in technical practice. A further object has been to apply the method directly to determine the unsaturation in soaps without separating the acids-which method always gives a low result. A still further object has been to apply the method directly to oils without previous saponificaton. That sulphuric acid in the method (loc. cit) which introduces some complication can be conveniently replaced has been also investigated. Further instead of saponifying the oil which was the first step before the application of hypochlorous acid in the previous process, it was seen that acetic acid solution of the oil can directly be employed to react with hypochlorous acid and the results obtained have been found to be correct. Different oils, non-drying, drying and semi-drying and different kinds of soaps have been examined by this method.

134. Synthesis of Para-Amidinophenylarsenoxide and its Derivatives.

B. Pathak *and* T. N. Ghosh, Calcutta.

Although filarial infections are widely distributed in the tropics, no potent and dependable filaricide has yet been discovered. Recently, promising results in the chemotherapy of filariasis have been obtained with some phenylarsenoxide derivatives by Otto and Maren (*Science*, 1947, 106, 105). These observations and also the fact that various amidine derivatives have recently been found to possess pronounced parasiticidal property have now stimulated the synthesis of p-amidinophenylarsenoxide from *p*-cyanophenylarsenoxide. The latter compound, which has been obtained by reduction of the sodium salt of *p*-cyanophenylarsonic acid(Linsker and Bogert, *J. Amer. Chem. Soc.*, 1933,66, 932) with sodium bisulphite in aqueous solution, has been easily converted into the corresponding amidino derivative. Both these cyano-and amidino-phenyl arsenoxide exist in hydrated forms. This amidino derivative has been condensed with ethyl acetoacetate to give the corresponding pyrimidine derivative.

135. Attempts to Synthesise 5 : 5–Diphenyl–3–phenylhydantoin.

T. N. Ghosh, Calcutta.

In view of the recent observation by Aird (*Chem. & Eng. News*, 1947) that 5-phenyl 5-ethyl-3-methyl-hydantoin is somewhat superior to 5:5-diphenylhydantoin in the treatment of epileptic conditions, it has been considered desirable to synthesise 5:5-diphenyl-3-phenyl-hydantoin(I), so that its toxicity and activity can be compared with those of the above drugs. With this idea in view, benzil has now been allowed to react with mono-phenyl-urea in presence of alkali, when a mixture of phenyl-carbamido-diphenylacetic acid (II) and 2-phenylamino-4:4-diphenyl-5-keto-4:5:dihydro-oxazole (III) has been obtained. The compound (III), which is readily hydrolysed by alkali to (II), has been proved to be identical with the compound obtained by Eberly and Dains (*J. Amer. Chem. Soc.*, 1936, 58 2546) by fusing mono-phenyl-urea with benzilic acid. Eberly and Dains, however, assigned to this compound the structure (I), which now appears to be untenable in view of the detailed study of its properties.

The action of 20% alkali on (II) furnished a mixture of 1-phenyl-3-diphenyl-methyl urea (IV) and a compound which is tentatively assigned the structure, 3:3:6:6-tetraphenyl-2:5-diketopiperazine (V).

136. Chemical Examination of the Fruits of Pistacia Integerrima. Isolation of Two Crystalline Products.

Prithwi Nath Bhargava, Banaras.

The fruits on steam distillation have yielded an essential oil to the extent of 0.9% of the crude drug and from the residual fruits, a white crystalline product m.p. 172

has been isolated in beautiful silky needles in an yield of 0.23%and another white crystalline product in silky needles m.p.110° in an yield of 0.35%. The first has been provisionally named Pistacin and the second as Pistacinin. Both these crystalline products are soluble in chloroform and pyridine, sparingly soluble in benzene, methyl alcohol and ethyl alcohol but insoluble in water. Both of these are extremely resistant to alkalies and acids. Studies on their constitution are in progress.

137. Studies in the Thiazole Series.—Part I–Synthesis of 2–Imino–4–keto–tetrahydrothiazole and its derivatives with aryl and alkyl substituents in positions 2 and 3.

PRITHWI NATH BHARGAVA, Banaras.

2-Imino-4-keto-tetrahydrothiazole, m.p. 200° has been synthesized by condensing formamidinethiolacetic acid, m.p. 234° obtained by the action of monochloroacetic acid on thiocarbamide, with glacial acetic acid.

Similarly 2-phenylimino-3-phenyl-4-keto-tetrahydrothiazole, m.p.176°; 2-*o*-tolylimino-3-*o*-tolyl-4-keto-tetrahydro-thiazole, m.p.155°; 2-p-tolylimino-3-p-tolyl-4-keto-tetrahydro thiazole, m.p.127°; 2-α-naphthylimino-3-α-naphthyl-4-keto- tetrahydrothiazole, m.p.172°; 2-β-naphthylimino-3-β-naphthyl- 4-keto-tetrahydrothiazole, m.p. 165° (decomp.); 2-*p*-anisylimino-3-*p*-anisyl-4-keto-tetrahydrothiazole, m.p.105° and 2-*p*-phenetylimino-3-*p*-phenetyl-4-keto- tetrahydrothiazole, m.p. 101°, have been synthesized by condensation of the corresponding diarylthiocarbamides with monochloroacetic acid in the presence of freshly fused and powdered sodium acetate using absolute alcohol as the solvent.

138. The Essential Oil of Zanthoxylon Rhetsa.

PRITHWI NATH BHARGAVA, Banaras.

From the carpels of Zanthoxylon rhetsa, the essential oil has been obtained to the extent of 0.5% by steam distillation. Some important characteristics of the oil are as follows :—

Colour	Light brown
Sp. gravity (30°C)	0.8610
Refractive index (30°C)	1.4609
Specific rotation $(\alpha)_D 30°$	–32.5°
Sap. value	2.73.
Acetyl value	39.07.
Acid value	6.03.

Detailed investigations regarding the active constituents of the fractions of the oil are in progress.

139. Dipole Moments of Aliphatic and Aromatic Alcohols.

S. K. K. JATKAR, R. J. SUJIR *and* B. R. Y. IYENGAR, Bangalore.

Assuming the fractional additivity law of polarisation to hold good in the case of solutions, dipole moments of benzyl, α and β phenyl ethyl alcohols, tetrahydro β-naphthol, α and β indanol and hexahydroxy benzyl alcohol have been calculated using the new relationship. The characteristic temperature when taken into account will not only eliminate the apparent decrease of moment with temperature but will bring down the absolute value of the moment to the vapour value of 1.68, generally observed for alcohols.

Biochemistry.

140. Disturbance in the Balance of Hepatic Glycogenesis and Glycogenolysis by Intermediary fat Metabolites and its Restoration by Amellin.

M. C. NATH *and* C. H. CHAKRABORTY, Nagpur.

The injection of sodium salt of B-hydroxy butyric acid on rats caused acceleration in glycogenolysis as a result of which the glycogen content of liver and muscle got depleted. Depletion of glycogen in liver and muscle is found to be 83 and 84% respectively after a period of injection for 55 days.

Simultaneously the lactic acid content in liver and muscle increased, the increase being 188 and 173% respectively during the same period.

The important glands and organs such as the liver, heart, kidney and stomach were found to be affected, a particular feature being a white tumorous growth in the liver.

Loss of weight was also marked in almost all the animals after the 3rd week.

Administration of amellin checked the depletion of glycogen in liver and muscle and also prevented the accumulation of lactic acid in the above organs, thus helping glycogenesis and checking glycogenolysis.

Animals receiving amellin along with the ketone bodies looked more or less normal.

141. Influence of Ionic Environment on the Invertase Activity of Yeast.

M. M. BISWAS, Calcutta.

Invertase extract from dried Brewers' yeast powder has been allowed to react upon 20% saccharose solution as substrate and the pH of the reaction mixture adjusted to 4.5 with additions of $\frac{N}{10}$ hydrochloric, sulphuric, citric, oxalic and acetic acids. Glucose formed by the volume of extract equivalent to 10 gms yeast powder has been estimated in presence of each of the acids and corresponding specific conductance values determined. Invertase activity has been found to maintain a constant level in presence of different anions at constant pH, though specific conductance values have changed. Experiments made with salts like KCl, $AlCl_3$, K_4FeCy_6, NaCl, Na_2SO_4, K_2SO_4, $CaCl_2$, $BaCl_2$ show a marked change in the invertase activity owing to varying valency of the constituent ions.

142. Effect of Ascorbic acid and other Substance on Ketolysis in Presence of Kidney Cortex.

M. C. NATH *and* (MISS) KUSUM LAUL, Nagpur.

1) Kidney cortex has been found to be more effective in bringing about the oxidation of Na-acetoacetate in vitro than the liver.

2) In presence of ascorbic acid in very small quantities (*i.e.* 1 mg. per c.c. of the solution) accelerates such ketolysis considerably.

143. Effect of Fat Metabolites on Blood Sugar and Lactic Acid Content in the Blood.

M. C. NATH *and* C. H. CHAKRABORTY, Nagpur.

1. Sodium aceto-acetate when injected in the normal animals (rabbits) in increasing doses beginning from 50 mg. per kg. caused hyperglycemia after an initial hypoglycemic stage.

2. When the dose was gradually increased to 150 mg. per kg. on the 8th week the average increase in blood sugar was found to be 73%.

3. The amount of lactic acid in the blood rose considerably after 8 weeks of such injection, there being observed an increase by 900%.

4. Some animals so treated showed typical diabetic sugar tolerance curves.

5. Enormous decrease in the ascorbic acid content of the plasma has been observed.

6. Loss of body weight was observed in all the animals.

144. p_H of the White and Yolk of Fertile Hen Egg during Incubation in Air, Carbon Dioxide and Liquid Paraffin.

M. A. WAJID, K. SUBBA RAO *and* B. SANJIVA RAO, Bangalore.

The variation in p_H is an important factor in the elucidation of the mechanism of many biochemical processes. The variation in p_H of the White and of the Yolk of fertile hen egg during incubation in air, carbon dioxide and liquid paraffin has been studied. After incubation over different intervals of time, the eggs were removed, the White and Yolk were carefully separated and the p_H determined by employing a glass electrode. In fresh egg, the White has a p_H of 7.85 and the Yolk 6.17. On continued incubation in air, the p_H of White increases to a maximum of 9.5 up to 36 hours and later decreases continuously. The p_H of the Yolk is practically constant up to the 2nd day and later increases slowly but continuously. The initial rise in p_H of the White is due to the loss of carbon dioxide and the subsequent fall to the metabolic processes resulting in the production of carbon dioxide. The small increase in p_H of the Yolk is probably due to the protein catabolism resulting in the formation of ammonia.

The p_H-Time curves of the White and Yolk of eggs incubated in carbon dioxide and liquid paraffin are practically coincident. The p_H of the White shows a small and continuous decrease and that of the Yolk a small and continuous increase. The conditions being anaerobic, the normal metabolic processes in the growing embryo are hindered. Consequently the changes in p_H are small.

145. Optical specificity of Protein Hydrolysate.

N. RAY, Calcutta.

Various proteins have been hydrolysed enzymatically and their rate of hydrolysis studied with respect to optical rotation. This is being found to be a linear function of the degree of hydrolysis, but the slopes differ with the nature of the protein.

146. Search for New Analgesics—Part III.

A. B. SEN *and* G. S. SIDHU, Lucknow.

In continuation of the work reported in Parts I & II of this paper (*Proc. Ind. Sci. Cong., Chem. Section,* 1947 & 1948), the synthesis of some more N-alkyl-substituted-γ-piperidones has been studied. Diethyl 1-ethyl-2, 6 diphenyl-4-piperidone 3, 5-dicarboxylate has been prepared by the method of Petrenko-Kritschenko (*Ber.,* 1909, 42, 3689) and has been reacted with several Grignard reagents. Phenyl magnesium bromide and ethyl magnesium iodide reacted with this piperidone to give the expected piperidols I & II respectively;

I diethyl 1-ethyl-2, 6 diphenyl-4-phenyl-4-piperidol 3, 5-dicarboxylate

II diethyl 1-ethyl-2, 6 diphenyl-4-ethyl-4-piperidol 3, 5-dicarboxylate

But *n*-propyl and *n*-butyl magnesium bromides yielded only plastic masses which could neither be crystallised nor distilled under high vacuum.

Industrial Chemistry.

147. Catalytic Oxidation of Ethylene.

S. K. K. JATKAR *and* S. V. S. RATNAM, Bangalore.

Dehydration of alcohol to yield ethylene has been carried out by passing hot vapours of alcohol over a bed of dehydrated potassium alum specially prepared for this purpose. This catalyst is found to be superior to alumina.

The oxidation of ethylene was carried out over vanadium catalysts with a view to partially oxidise ethylene to formaldehyde. In the initial stages the catalysts gave as much as 25% yield of mixtures of aldehydes for a single pass, and got poisoned due to the deposition of carbon on the catalysts.

148. Chlorination of Ethylene.

S. K. K. JATKAR *and* S. V. S. RATNAM, Bangalore.

Chlorination of ethylene was carried out by passing both ethylene and chlorine in ethylene-di-chloride in a glass vessel. It was found that at 25°C about 60% of the product formed was 1, 1, 1, trichloroethane or methylchloroform, 25% ethylenedichloride, and 15% 1, 1, 2, trichloroethane.

Using iron at room temperature in the form of turnings as a catalyst the products formed were 25% ethylene dichloride, 25% ethylidene chloride, 40% trichloroethane (1, 1, 1) and 10% 1, 1, 2, trichloroethane.

The chlorination over calcium chloride was carried out in the gas phase at 100°C. Using either an iron or glass apparatus it was found that about 80% of the products was ethylenedichloride.

149. Oxidation of Ethyl Alcohol under Silent Electric discharge Part I. Formation of Formaldehyde and other Oxidation Products.

R. H. SAHASRABUDHEY *and* S. M. DESHPANDE, Banaras.

Alcohol vapour-air mixtures obtained by bubbling air under varying pressures through ethyl alcohol at different temperatures, have been subjected to silent electric discharge in a Siemens' glass ozonsier at 7.8–8.4 kV and 500 cycles. The effluent gases were washed off the soluble products by passing them through a series of water wash-traps. Presence of formaldehyde, acetaldehyde, formic acid, and acetic acid was detected in the washings. For 3 to 5 cc of rectified spirit consumed the yield of formaldehyde as estimated by potassium cyanide method was found to range between 0.036 gms. to 0.047 gms, the total acidity of the solution corresponded with 0.06 gms. to 0.10 gms. of NaOH. Acetaldehyde, formic acid and acetic acid were not estimated quantitatively.

The results are of interest from the point of view of the possible utilization of low concentration fermentation alcohol for the production of raw materials for plastics and other allied industries.

Further investigation is in progress.

150. Rancidity of Mohua Oil.

V. N. GODBOLE *and* B. N. BANERJEE, Bangalore.

Commercial samples of Mohua oil contain considerable quantities of free fatty acids, 5 to 27%. This high f.f.a. lowers its market value and is the cause of rancidity even when made into soaps. When fresh seeds were collected, dried and the oil was extracted by us, the free acidity was only 0.4%. However, fresh seeds of Mohua have a moisture content as high as 40%. Therefore, high f.f.a. is due to fungus growth on Mohua seeds that are not properly dried or stored. Even dry seeds in presence of moisture and summer temperature develop high acidity, 20% in a fortnight and 40% in a month. The iodine value goes down from 57 to 36. An analysis of the f.f.a and fresh oil, however, shows that this acidity rise is similar to those observed in the case of other oils and fats. Mohua oil has a high percentage of unsaponifiable matter, 2%. This fraction also undergoes changes on development of rancidity. The alcohol insoluble part of unsaponifiable matter is highly pro-oxidant compared to the alcohol soluble portion about 7 times in activity—at all dilution of even 0.03%.

The high percentage of unsaponifiable matter and its catalytic effect is responsible for the progressive development of f.f.a. in Mohua oil. If Mohua seeds be collected and dried and stored properly then the acidity can be held about 1% only.

151. Linoleic Acid Content and Detection of Adulteration of Ghee (Butter-Fat).

T. A. VENKATASUBRAMANIAN *and* B. N. BANERJEE. Bangalore.

The limits of natural variations due to breed, feed, season etc. of the Linoleic acid content of about 400 samples of ghee collected from all over India were estimated from the iodine and thiocyanogen values. It was found that in 90% of the cases the linoleic acid was not more than 2%, the remaining 10% giving figures between 2 and 2.5%.

Three samples of ghee of high, low and average iodine value were examined for their fatty acid composition by the ester fractionation method and the linoleic acid of the specimens were Wardha, 1.8%, Ahmedabad 1.1%, and Junagadh, 1.9% having an R.M. of 18.5, 30.1 and 36.0 respectively.

The samples containing more than 2% linoleic acid were rancid and had f.f.a. varying from 2 to 10%. They gave a bluish tinge when fluoresced in ultra-violet light.

The data confirm the proposition put forth before that low R.M. genuine ghee can be distinguished from adulterated samples by estimating the linoleic acid content of ghee. This can be confirmed by a fluorescence analysis in ultra-violet light.

152. On the Bleaching Properties of Indian Clays.

S. C. CHAKRABARTY *and* R. K. DUTTA ROY, Calcutta.

Bleaching properties of some of the Indian clays have been studied. It was found from the data available that clays treated with 5.0%HCl for activation gave good results, the clays having good bleaching properties when Silica and Sesqui-Oxides are present in almost equal proportion. The results so far obtained seem to be interesting and further investigation is in progress.

153. Electrolytic Production of Persulphuric Acid on Semi-commercial Scale for the Electrochemical Preparation of Hydrogen Peroxide.

D. SINGH *and* A. BANDYOPADHYAY, Banaras.

Literature shows that the optimum conditions for the production of persulphuric acid are available at low temperature 0.5°, which is very difficultly maintained in a tropical country like India. The optimum conditions at a conveniently maintainable temperature has already been done by Sheshadri ((*Proc. Ind. Sci. Cong.*, 1942, Part III, p. 43). The results are reinvestigated in considerable detail; the optimum conditions are: anodic C.D.=61.0 amps. per sq.dcm; cathodic C.D.=125.0 amps. per sq.dcm; interelectrode distance=5.0 cm; concentration of the electrolyte=60.0 % H_2SO_4 (Sp. gr.=1.505); temperature=20.0°C; electrode material used=platinum. The maximum current efficiency is 70%, with the progress of electrolysis for half an hour. The increase in volume necessitates the corresponding increase in current to keep up the desired current effiiciency; but it is observed that the current need not be in the same proportion as the volume. For a particular volume a definite magnitude of current produces the best yield.

The yield obtained with a fresh solution of sulphuric acid and that which has been kept to stand for 20 hours after electrolysis and re-electrolysed, have been compared. During half an hour interval of electrolysis the yield of perdisulphuric acid is almost the same in both cases but in the latter case the formation of permonosulphuric acid is considerably low. The use of two anodes in place of one diminishes the yield to almost half of its former value. This is in agreement with the finding of Berthelot that with increased area of anode the possibilities of the decomposition of persulphuric acid increase and consequently the current efficiency diminishes. (T. Slater Price, 'Per-acids and their salts'. Longmans, Green and Co., 1912, p.14).

154. Catalytic Cracking of Kerosine Oil.—Part II.

S. S. GHOSH.

Pilot plant investigation into the economic possibility of making laboratory gas by catalytic cracking of kerosine oil has been carried out. A brief description of various parts of the plant made by assembly of readily available materials is given. The essential features of the plant, such as the pressure heating arrangement for vapourisation of oil and the design of a suitable immersion heater are described. Calculations based on a tentative heat balance are embodied which enable the capacity of the unit to be determined. Experiments with the plant indicate the possibility of a minimum yield of 35 c.ft. of fairly rich gas suitable for laboratory burners at the expense of 1 K.w.h.

155. Decarboxylation of Fatty Acids.

M. CHAKRABARTY *and* M. GOSWAMI.

In continuation of previous paper on the subject (*J. Ind. Chem. Soc.-Ind. & News Ed. Vol. IX.* Nos.3 & 4, 1946) in which we had shown that oleic acid, a bye-product in the manufacture of stearic acid, is decarboxylated in presence of catalysts like Kieselghur, Zinc, Nickel, Copper etc. into hydrocarbons, we have tried various other catalysts and studied the conditions in detail.

Oleic acid vapour was passed over Cu and CuO at a temperature of 380-385°C, under reduced pressure. But results were obtained with reduced copper. Separation and analysis of the products formed were done. The effect of re-cracking the primary product under the same conditons was also studied.

156. Moulded Articles from Glue.

S. K. BASU *and* M. GOSWAMI.

The purpose of the present work is to prepare a suitable thermo-hardening moulding powder from glue and a plasticiser for the same. Previous attempts have been made by various reagents to harden glue of which formaldehyde and dichromate are the notable examples. For our purpose, firstly, we prepared glue powder by dehydrating it in inert solvents. This was mixed with powdered hexamine and the moulding characteristics were noted.

157. On the Preparation of Desizing Agents.

H. N. CHATTERJEE.

An extract suitable for preparing active desizing agent has been made by growing a strain of *Aspergillus Oryzae* on an acidified wheat bran admixed with 25% fat-free ground-nut meal and 1.25% sodium phosphate. The activity of the extract as measured from lowering of viscosity of a starch solution, compares favourably with similar extracts made from a commercial desizing agent exported from abroad.

158. Studies of Some Factors Affecting the Characteristics of the Dry-cell.

N. N. S. SIDHANTA, Banaras.

Effects of particle size of the main constituent of the depolarizer, *viz*, pyrolusite ore, the use of artificial or/and natural graphite in the depolarizer and substitution of zinc chloride by zinc bromide in the electrolyte of a dry cell were studied. The results are recorded betow.

It was found that the internal resistance of the cells with 50 and 100 mesh fine ore, was low in the beginning *viz.*, 0.17 ohms, whereas it was 0.35 ohms in those with 200 mesh fine ore. The watt-hour capacities were 3.88, 4.70 and 3.58 respectively. The life of the cells with 100 mesh fine ore was found to be the longest and that of cells with 200 mesh fine ore the shortest.

The change in the nature of the graphite used *e.g.*, natural, artificial or a mixture of the two varieties was found to bring about no marked change in the properties of the cells.

The substitution of zinc chloride by zinc bromide was found to increase the initial internal resistance and decrease the life and watt-hour capacity of the cells, the latter being only 3.72.

159. The Tensile Strength of Synthetic Fibres.

P. S. VARMA *and* ABHAYA SINHA, Banaras.

The synthetic fibres from (a) hemp, (b) jute, (c) bamboo, (d) linen waste, (e) waste thread from mills, (f) commercial cotton, (g) cotton linterns and (h) surgical cotton, have been prepared on Higihara model Viscose Rayon Spinning Machine obtained from Messrs. Kotak & Co., Osaka, Japan and their tensile strength compared.

160. Studies in Processing of Tangerine Juice.

A. N. BOSE *and* A. K. GHOSH.

Canning of tangerine juice is difficult because of the delicate flavour of the juice which cannot be reserved by methods now in use for processing of other citrus juices. Moreover, the optimum conditions for deaeration which is necessary for retention of vitamin C in the juice, are not knowm. In this study it has been observed that a minimum of 1.6 percent, by volume, of air should be allowed to remain in the juice, when canned; otherwise juice will taste very flat. Loss of vitamin C due to 1.6 percent of air in the juice is negligible even after two months storage at 28°C. A temperature of 31°C and vacuum of 20 inches of mercury will provide the optimum conditions for deæration. A sample of juice, deaerated under optimum conditions to 1.6 percent (by volume) of air and pasteurised at 86°C. for 15 secouds, retains, when canned, its flavour and its original vitamin C content almost unchanged for at least two months at a storage temperature of 28°C.

161. Investigations of the Indian Lemon Grass Oil.

H. G. BISWAS, Calcutta.

Conditions for the isolation of pure citral from Indian Lemon grass oil have been successfully established in the laboratory. Difficulties in the conversion of the process into the large scale preparation with a view to the economic production of ionone in India have been pointed out.

162. Possibilities of Earth as a Building Material in India.

N. K. PATWARDHAN, Roorkee.

The paper reviews the possibility of utilizing earth as a suitable building material in these days of scarcity of the conventional building material. Buildings in Pise-de terre and adobe have been described with details of construction in both the cases. The inportance of moisture content in the soil mixture is stressed. The processes have been modified and compared in order to decide which of these would suit our requirements. Simple test for determining sand, even by a layman, has been described. Reference is also made to the use of different indigenous substances as soil stabilizers used at the Building Research Unit by the author. This includes gum, resins and lime-sludge. The last substance has been found quite useful as internal water-proofing agent together with ramming. This substance which is wasted annually in thousands of tons by the sugar factories as a bye-product would find a very useful application in the construction of low cost housing, using adobe blocks (kuchha bricks) and suitable water repellent mud plaster of lime-sludge.

163. Bactericidal Action of Some Organic Mercuri-compounds of Aryloxy Fatty Acids.

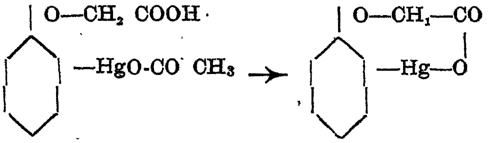
SACHINDRA KUMAR DUTTA *and* S. S. GUHA SARKAR.

The aryloxy acetic and propionic acids used in the investigation were prepared according to standard methods and recrystallised from hot water. Phenoxy acetic acids from phenol, o-, m- & p-cresols, o-m, and p-nitrophenol, o-m- and p-chlorophenols, α and β naphthols, guaiacol and thymol were known, as well as the phenoxy propionic acids from o-cresol- and o-nitro phenol. In most of the cases only the m-p's are recorded and neither the methods of preparations nor their reactions are described. The physiological effects of the majority of these compounds have not been studied.

The equivalent weights of unknown acids were determined by titration with standard alkali in dilute alcoholic solution.

The mercuri-derivatives were prepared by the method given in text book of Inorganic Chemistry by J. N. Friend, Vol XI, part 7 (1928). Only seven acetoxy mercuri-derivatives *viz.*, those from phenol, o-cresol, o-chlorophenol, thymol, α and β naphthols and guaiacol are known. The others were new.

Estimation of mercury was carried out by the Gold crucible method. The data and determination of the equivalent weights indicated that the compounds were the anhydrides of the hydroxy mercuriphenoxy-acetic acids and not the acetoxy derivatives as might be accepted.



Di-mercury compounds could be prepared by using two molecules of Hg acetate. These derivatives were not stuoied in detail.

The mercuri derivatives were paractically insoluble in water and organic solvents, but were soluble in NaOH from which dilute acids reprecipitated them unchanged.

They were decomposed by warming with dilute HCl or NaCl solutions but not by shaking with $(NH_4)_2 S$. Neutral solutions of the acids gave insoluble precipitates with $CuSO_4$, $P_6 (OAC)_2$ $FeSO_4$, and $ZnSO_4$ but none with Barium chloride or Calcium chloride.

Anhydrides of acetoxy mercury-phenoxy propionic acids were prepared in the same way and very similar properties were shown. These were somewhat more easily decomposed by HCl and $(NH_4)_2S$.

Bactericidal Test

For testing this action the Rideal-Walker drop method was followed. The organisms chosen for study were fresh cultures (24 hours old) of B. Coli and B.Paratyphosus B. Except a few, all the compounds easily dissolved in dilute NaOH to give nearly neutral solutions which were used in the tests, and were diluted with twice distilled water for the dilution tests. The pH of the solution and of the medium employed for the growth of the organism varied between 7.4 and 7.8. The temperature was 29°C.

The maximum effective dilution (concentration which prevented growth of B. coli) varied from 1 in 10,000 in the case of Phenoxyacetic acid derivative to 1 in 170,000 in case of p-iodo phenoxy acetic derivative. In case of B. paratyphosus B, the corresponding figures were 1 in 10,000 in case of the first and 1 in 130,000 in case of the p-iodo compound.

The unmercurated phenoxy acetic and propionic acids were very much weaker in activity; the maximum effective dilution varied from 1 in 700 in case of the first and 1 in 4,000 in case of β naphthol derivative and p-iodophenol derivative.

This clearly showed the large increase of bactericidal action on the introduction of Hg in the mol. Below is given a list of the compounds studied: They were the anhydrides of the hydroxymercuri derivatives of: 1. phenoxyacetic, 2. o-cresoxy acetic 3. m-cresoxyacetic, 4. p-cresoxyacetic, 5. o-Nitrophenoxyacetic, 6. m-Nitro.., 7. p-nitro.., 8. o-chloro.., 9. m-chloro.., 10. p-chloro.., 11. α-naphthoxy.., 12. β-naphthoxy.., 13. o-xylenoxy.., 14. m-xylenoxy.., 15. guaiacoxy.., 16. thymoxy.., 17. p-Iodophenoxy..,

18. β-phenoxypropionic, 19. β-o-cresoxypropionic, 20. β-guaiacoxypropionic, 21. o-nitrophenoxypropionic and 22. p-nitrophenoxypropionic.

164. Rapid Alkalimetric Method of determination of Magnesium in Carbonate ores of Calcium and Magnesium.

S. C. SANE *and* M. S. TELANG, Nagpur.

An acid-alkali method using lime water is recommended for the rapid estimation of magnesium in carbonate ores for limestone prospecting work for Portland cement manufacture. The main advantage of this method is that magnesium can be estimated rapidly even in the presence of iron and aluminium, the usual impurities in the ore. The reagents are inexpensive and readily available for routine analysis in Portland cement works laboratories.

165. On the Mechanism of Viscosity of Liquids.

M. S. TELANG, Nagpur.

A new viscosity-temperature relationship for liquids has been derived and its application has been studied. The derivation is based upon the theory of viscosity by Eyring *et al.*, rectifying the "activation energy" term. The "activation energy" term has been shown to be equivalent to the free energy of formation of a surface, and the error committed by previous workers regarding the evaluation of "activation energy" has been discussed. The proposed equation is free from any aribitrary or empirical terms and particularly not being derived from viscosity measurements, makes a direct calculation of viscosity possible.

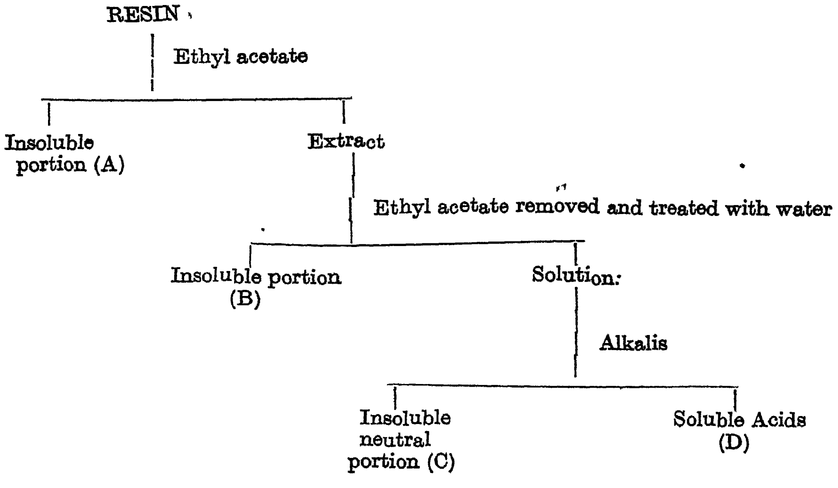
166. Apparent Molal Volume of Sodium Chloride in Aqueous Solution.

BALBHADRA PRASAD *and* SHAYMASUNDER PANDA.

The apparent molal volume (ϕ) of electrolytes should be represented by an equation of the type; $\phi=\phi_0+a\sqrt{c}+bc$ where '*a*' is same for all electrolytes of the same valance type. There has been a good deal of difference in the results obtained with different salts of the same valance type. To see whether the differences are due to experimental error or are real, density measurements have been made to an accuracy of two in a million with help of two pyknometers of the same size, one containing solution and the other containing the solvent at the same temperature. The experimental value of '*a*' is very nearly equal to the theoretical value.

167. Investigations on the Resin from Shorea Robusta.

D. MUKHERJEE *and* P. C. GUHA, Bangalore.



Neutral ethyl acetate insoluble fraction (A). By fractional precipitations from benzene-alcohol mixture (1:2) and fractional crystallisation from ethyl acetate it was resolved into a crysatalline product, m.p. 170-80° and a product m.p. 208-10°.

Ether insoluble acids fraction (B). Purification by fractional alkaline extraction yielded a pure acid (with 5% ammonia), m.p. 308-10° ; equiv. wt., 489. From the high acetyl value and the equivalent weight it seems to be a poly-hydroxy triterpene acid.

Ethyl acetate soluble neutral fraction (C). This is soluble in all organic solvents On fractional distillation two fractions, b.p. 175-80°/2 mm.; and 200-205°/2 mm., respectively, were obtained.

Ether soluble acid fraction (D). The fraction extracted by 5% ammonia, during fractional alkaline extraction from this fraction on working out gave an acid mixture (m.p. 200-204°; equiv. wt., about 600; absorbs bromine in the cold).

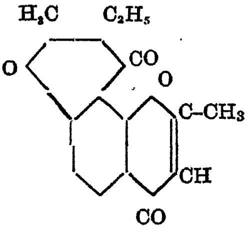
Chromatographic separation of the component acids was effected using benzene as solvent and columns of activated talc. The acids were located in far distant portions in the train of elution, by titration against N/100 alcoholic caustic potash. Each influx of acid eluted was rechromatographed till there was no further resolution.

Nature of active chemical groups, *e.g.*, carboxyl, keto, hydroxy, ester, etc., present in the constituents of the different fractions (A), (B), C), and (D) have been determined.

168. Synthesis of 2 :2′-Dimethyl-3′-ethyl-chromone-7 :8- -pyrone from 7-Hydroxy-8 butyryl-2-methyl-chromone.

G. R. Kelkar *and* V. S. Kulkarni, Poona.

7-Hydroxy-8-butyryl-2-methyl-chromone (Kelkar and Kulkarni, *Proc. Ind. Sci. Congress*, 1945, 140) gave by the action of fused sodium acetate and acetic anhydride, a neutral substance, $C_{16}H_{14}O_4$, m.p. 227°, (I), which on alkaline hydrolysis gave 2-butyryl-4-carboxy resorcin (Kelkar and Kulkarni, *ibid.*) by ketone-splitting of one of the pyrone rings and acid-splitting of the other pyrone ring yielding (i) acetone and (ii) acetic acid respectively as the other products of hydrolysis. (I) could, therefore, be represented as 2:2′-dimethyl-3′-ethyl-chromone-7:8-γ-pyrone,



169. Synthesis of 3-propyl-2′-ethyl-7′-8′-furochromone by the Roessing's method.

G. R. Kelkar *and* V. S. Kulkarni, Poona.

Dry sodium salt of 7-hydroxy-8-butyryl-2 methyl-chromone (Kelkar and Kulkarni, *Proc. Ind. Sci. Congress*, 1945, III, 140) gave by the action of ethyl-brom-acetate 7-carbethoxy-methoxy-8-butyryl-2-methyl chromone, $C_{18}H_{20}O_6$, m.p. 125°, (I), which on mild hydrolysis with caustic alkali furnished the corresponding acid, 7-carboxy-methoxy-8-butyryl-2 methyl chromone, $C_{16}H_{16}O_6$, m.p. 240° (decomp.) On heating alone or with acetic anhydride and sodium acetate (II) yielded by the elimination of carbon dioxide and a molecule of water, 3-propyl-2′-ethyl-7′:8′-furochromone, $C_{15}H_{14}O_3$, m.p. 155°.

170. The Electro-deposition on Non-conducting Surfaces.

D. R. Dhingra, G. N. Gupta *and* M. G. Gupta, Kanpur.

The electroplating of non-conducting surface is not possible, unless they are rendered conductive by some means. There are three methods which are widely used to obtain a metallic-coating on non-conducting surfaces, namely : (1) Metal Spraying ; (2) Vacuum-Spluttering and Evaporation ; and (3) Electroplating. The first two processes require the use of special apparatus. The third one has been dealt in detail in this paper.

In order to electroplate a metal on a non-conducting surface, it is necessary to form a thin conducting layer before placing it in the plating solution. This can be done either (1) by means of metal-powders or (2) by reduction of metals on the surface. Both these methods have been described. For copper plating acidic-copper sulphate, alkaline copper tartrate and cyanide baths have been tried, but only least acid copper sulphate and acid copper-sulphate baths have been found satisfactory.

The authors have successfully electroplated several non-conducting surfaces, *viz* : glass ; plastics ; wood ; wax ; plaster of paris and unglazed articles ; porcelain and tiles, etc.

For copper plating glass it is first of all silvered by reducing ammonical silver nitrate either by dextrosol or hydrolysed cane sugar. Then it is copper plated first of all in the least acid copper bath and the copper film thus produced then thickened in the acid copper bath. The composition and optimum operating conditions have been given in detail in the paper.

For electroplating plastics in general and celluloid sheets in particular, first of all the surface is deglazed, cleaned and sensitised with 1% pyrogallol solution and then a thin silver film is deposited on it chemically. After drying, the silvered celluloid-sheets are copper plated, as in the case of glass, in the least acid copper bath and finally thickened in the acid copper bath. The copper plated sheets may also be plated with silver in the following silver plating bath. The composition of the recommended bath is as follows : Silver-nitrate 74 gm.; Potassium cyanide (95-96%) 82 gm.; Potassium carbonate 76 gm.; Sodium thiosulphate 1 gm.; water to make up to two litres. The optimum working conditions are as follows : Temperature 25-28°C,; voltage 3.0 volts; cathode current-density 40-45 amp./sq. ft.; plating time 60 seconds.

For electroplating of wood and wax, a conducting surface was obtained by applying a thin uniform layer of 6% collodion and after drying treating them similar to celluloid-sheets. Wax can also be made conductive by applying a layer of 1:1 copper powder and graphite and then silvering it as usual.

For electroplating of plaster of paris moulds and unglazed articles, they were first of all coated with wax and then treated as in the case of wax articles. Procelain articles and tiles were rendered conductive by direct silvering as in the case of glass plates.

171. The manufacture of Electrolytic Copper powder.

D. R. Dhingra, G. N. Gupta *and* M. G. Gupta, Kanpur.

Copper powder plays an important role in the manufacture of nearly 75% of all the metal powder parts. It also finds wide use in the electroplating of non-conducting surface—electro-typing, etc., besides other industrial applications. After describing briefly the four important methods of making copper powder namely, (1) by reduction of the oxide: (2) by atomisation of the molten metal ; (3) chemical precipitation ; (4) by electrolysis, the authors have given the details about the manufacture of electrolytic copper powder on a semi-large scale. The optimum working condition with regard to composition of the electrolyte, current-density, tank voltage bath-temperature, electrode-spacing, etc., have been determined. The relations between current-density and tank voltage, sp. gr. of the solution and the combined concentration of sulphuric acid and copper sulphate, sp. gr. of the powder, its particle size, etc., have been thoroughly studied. The results obtained considerably differ from those reported by Hothersall and Gardam ("The Industrial Chemist," *167*, April, 1945.).

It has been found that an electrolyte containing in solution 50 gm./L. of copper sulphate ($CuSO_4$, $5H_2O$) and 150 gm./L. of free sulphuric acid (sp. gr. 1.84) with a cathode current-density of 70-75 amp./sq. ft. at 1.5 volts works well at 25-35°C. The electrode distance may vary from 4.0″ to 5.0″. The various precautions that are necessary for proper working have also been mentioned.

In the end details about the necessary equipment and economics for producing 1 cwt. of loose copper powder per day of 24 hours have been given. It has been estimated that the cost of loose copper powder will be approximately Rs. 3/-/- per lb.

As the raw materials are available within the country, Indian capitalists should avail of the facilities to start the industry.

172. Survey of Reh Deposits in U.P.

D. R. DHINGRA, GANESH CHANDRA, G. N. GUPTA *and* V. N. NIGAM, Kanpur.

It is well known that soda ash and caustic soda are two of the most important chemicals required for the development of industries in the country. During the war time due to the transport difficulties their supply from foreign countries was much restricted. It therefore became essential to manufacture soda ash and caustic soda from the raw materials available in the country. Reh soil which occurs as a efflorescence on the surface of earth in usar lands during the dry months contains sodium carbonate to the extent of 3-20% along with other soluble salts like sodium chloride and sodium sulphate. This has been known to washermen who were using it for cleaning the textile goods, though it had not been exploited economically so far. Sajji has been made in the United Provinces since a long time and about 7-8 lacs mds. are produced annually. To develop this industry a survey of reh deposits occuring in various localities of the Province was made and the samples from these places were fully analysed in order to find out the composition of reh soils.

It has been noticed that good quality reh generally occurs by the sides of canals. Authors have shown that if all the reh available in our Province is utilised for the manufacture of soda ash the quantity would be much more than enough to meet our demands in the country.

173. Resins from Molasses, sugar and other Carbohydrates.

M. S. BHATNAGAR *and* S. ROY, Kanpur.

Dark coloured resins from molasses and phenol have been prepared. Experiments were conducted under pressure in an autoclave and also by refluxing the products with an acid catalyst. Optimum conditions of the reaction have been determined and it is found that the maximum yield is obtained when the reaction is carried out between two parts of molasses and one part of phenol.

Attempts to reduce the percentage moisture have all been made and a minimum of 0.09% has been recorded.

Experiments with sugar and other carbohydrates have also been conducted to produce lighter coloured products.

174. Studies in Cellulose–Acetates.

D. R. DHINGRA *and* B. B. MITHEL, Kanpur.

The authors have studied the manufacture of cellulose-acetates in its multifareous aspects. Various catalysts and reactants in different proportions at different temperatures, time of reaction, have been used. As the pretreatment of cellulosic raw material *i.e.* cotton etc. before the acetylation is of great importance, the effect of various treatments have been studied in detail and discussed in its comparative aspects.

The common catalysts used in acetylation of cellulose have been studied individually and discussed fully. Perchloric acid, sulphur dioxide and chlorine, zinc chloride, and sulphuric acid were employed as catalysts. Sulphuric acid, the universally employed catalyst on commercial scale, was studied in great details. It has been noticed that the time of action is reduced by increasing the quantity of sulphuric acid. It was observed that by increasing the concentration of sulphuric acid, the speed of acetylation increases, but after a certain limit of time, the degrading effect becomes very prominent. The desired commercial products can be obtained by varying the amount of sulphuric acid.

As the Government is planning the development of plastics and acetate rayon industry, the above work will solve most of the initial difficulties and the work will prove of fundamental importance to the industry.

175. Studies in the manufacture of Cellulose-acetate-butyrate.

D. R. DHINGRA *and* B. B. MITHEL, Kanpur.

Cellulose-acetate-butyrate, the most popular mixed ester of cellulose, is used as a plastic, lacquer, and coating material. It finds extensive use in the manufacture of aeroplane dopes, radio bodies and furniture, film making and lacquers for plastics and fine steel tools.

The manufacture of cellulose-acetate-butyrate happens yet to be a top secret. Studies conducted in its manufacture have met with considerable success. The weight percent acetyl and butyryl in cellulose-aceto-butyrate was found to be a mere function of the initial proportions of acetylating and butyrylating groups in the reactant mixture. For very high butyryl and acetyl content cellulose-acetate-butyrate, the use of both the anhydrides in the reactant mixture is essential. For moderately esterified cellulose-acetate-butyrate the presence of one of the anhydrides only is required. Very low acetyl and butyryl content aceto-butyrates can be manufactured without the use of anhydrides.

This fundamental study in the manufacture of cellulose-aceto-butyrate will be of great value to the Indian plastic industry which is going to be developed shortly in our country.

176. A Survey of Indian Cellulosic Raw Materials for the Manufacture of Rayon.

D. R. Dhingra *and* B. B. Mithel, Kanpur.

All the Indian cellulosic raw materials, which can be employed for the manufacture of rayon, have been studied in detail. Some of them have not been explored so far. Taking all the points into consideration, cotton waste and bagasse have also been found out as suitable raw materials besides several woods, which can produce chemical pulp for rayons.

Cotton waste, bye product of the 'Cotton spinning and weaving Industry', unsuitable for spinning and carding etc. (specially the soft waste), is quite a good and economical raw material. It does not need any elaborate chemical treatment like other cellulosic raw material, being merely an admixture of cellulose, dirt and earth, seed parts and straws etc. and can yield cellulose quite economically. The treatments required are mainly of mechanical nature. The authors have estimated that cotton waste alone, if available for the chemical cotton industry, would yield nearly 3,54,150 bales of chemical cotton anually. Chemical composition of cotton waste from various operations of the textile mills differs.

Bagasse, another raw material is obtained as a bye product in sugar industry. The processes of pulping of bagasse have been studied, but of the existing methods *i.e.* soda, sulphate, sulphite and nitric acid, the last method has proved best. By using the nitric acid method of pulping bagasse, the authors could get as high as 95% α-cellulose in the prepared pulp. As there are a number of sugar factories in U.P., very large amounts of bagasse can be available for rayon manufacture and it can be exploited commercially in the Province.

177. Plaster for Kachha Houses.

D. R. Dhingra *and* S. N. Ghatak, Kanpur.

Due to great shortage of building materials such as cement, bricks, iron, houses cannot be made to the desired extent. Mud and sun dried brick houses are to be made to a very great number. Mud and sun dried brick walls cannot resist rain and hence with a view to make suitable plaster for applying over sun dried and mud brick walls, a series of experiments were performed and a suitable plaster was evolved as follows :- (1) Kachha water pond clay—10 cu. ft. (2) Cow-dung—2.5 cu. ft. (3) Wheat straw—2 cu. ft. (4) Linseed fibre—1 cu. ft. (5) sunnhemp fibre—1 cu. ft. (6) mud from cattle farm—1 cu. ft. (7) Molasses 10 seers.

Suitable clay (soil) selection is essential as every clay does not serve the purpose as they are not identical and vary considerable in behaviour.

The selected clay was dried to const. weight and was analysed and the result was as follows :-

SiO_2=55.1% (Free silica was 15.0%), Fe_2O_3 & Al_2O_3=23.77%, CaO 3.31%, MgO 8.69%, Organic matter and Humus content 7.90%, Undetermined by difference=0.73%;

Physical Tests :-

Tensile strength 210 lbs. per sq. inch, Liquid limit 45.9%, Plastic limit 20.3%, Plastic index=25.6%, Optimum moisture required 12.0%.

Clay from different ponds vary considerably. If necessary different proportions of different soils are admixtured in order to get the figures as above analytical figures.

The above formula was used for plastering the mud and mud brick walls and also for reinforced roofing.

The above formula was termed as A. To this A, B was added in equal volume and mixed intimately. The composition of B part is as follows :- (1) Press mud 10 cu. ft., Bagasse 4 cu. ft., Molasses 15 seers.

The process of stabilization :– The ingredients are mixed and kept dipped in water for 25 to 30 days and allowed to undergo biochemical fermentation changes, with occasional stirring by manual labour. If the stabilization period is increased the quality of plaster improves to a great extent. Chemical action during stabilisation is due to fermentation and chemical combination of various ingredients found to form a plastic mass.

A number of houses with (1) Mud, (2) sun-dried bricks and (3) sun-dried bricks with minimum (about 20%) amount of fired bricks of the total number have been constructed. Plastering of walls with stabilised mud was done. Some roofings were also made of stabilised mud over a bamboo strips screen (Jaffri) which acted as a reinforcing material. Walls and roofings were lime washed.

178. On Dalda Vanaspati.

D. Mishra

Dalda Vanaspati in the opinion of the foreign as well as a few Indian Scientists is pure and wholesome food stuff. The original sample which was analysed in Imperial Science Institute, India and also Science Institute, Bangalore was found to contain cocoanut oil 20%, groundnut oil 20%, cotton seed oil 25%, Mohua oil 15% and the rest 20%, butter prepared by souring pure milk slightly by controlled enzymic action. Gradually small traders began to adulterate the Vanaspati inspite of the Government Notification of the Department of Food: The Vegetable Oil Products Controller for India hereby prohibit the manufacture, stock or sale of any vegetable oil product which does not conform to the following particulars :—

1. The melting point as estimated by capillary slip method shall be from 31°C to 37°C, both inclusive with a tolerance of 2°C either side. The product on melting should be clear in appearance.
2. It shall not have moisture exceeding 0.25%.
3. It shall not have unsaponifiable matter exceeding 1.5%.
4. It shall not have free fatty acid exceeding 0.25%.
5. It shall not contain any harmful colouring, flavouring or any other matter deleterious to health.

The following results were obtained in my Laboratory on Dalda Vanaspati of different samples.

1. Melting point..........34°.5C–42°C. The product on melting is not clear.
2. Moisture...............0.28%–0.78%.
3. Unsaponifiable matter...1.75%–2.2%.
4. Free fatty acid..........0.35%–0.74%.
5. Colour and flavour......Doubtful.

Besides these, saponification value and Iodine value differ widely from those determined in different laboratories in India with the original sample.

In my opinion the present Dalda Vanaspati is adulterated and hence inferior to the original sample.

Further investigations on other points are incomplete and still under progress.

179. Alkyl Substituted Benzylamines.

N. V. Bringi, N. L. Phalnikar *and* B. V. Bhide, Poona.

β di (phenyl ethyl) amines have good local anesthetic, antispasmodic and analgesic activity. Benzhydryl ethers and N-benzhydrylamines have shown high antispasmodic activity. It appeared therefore worthwhile investigating α-alkyl benzylamines and their derivatives for their local anesthetic, analgesic and antispasmodic action. In the present work α-alkyl benzylamines with or without substituents are described. These were put through a screening test for their local anesthetic activity in B. J. Medical College, Poona.

The following amines are prepared : α phenyl ethyl amine ; α phenyl propylamine ; α propyl benzylamine ; α hexyl benzylamine ; α (p-methoxy phenyl) ethyl amine ; propyl p-methoxy benzylamine ; α hexyl p-methoxy benzylamine ; α tridecyl p-methoxy benzylamine ; α heptadecyl p-methoxy benzylamine ; α chlorophenyl ethylamine ; α propyl chloro benzylamine.

α phenyl ethylamine, α hexyl p-methoxy benzylamine and α hexyl benzylamine have considerable local anesthetic activity.

In continuation of the work described in part I (*Abs. Proc. Ind. Sci. Cong.* 1948, Part 3, 36) these amines were tested for their antitubercular activity. α hexyl benzylamine and α hexyl p-methoxy benzylamine inhibited completely the growth of M. Tuberculosis in a concentration 1 in 1000.

180. Azo Dyes from Sulfa Drugs and o-, p-Alkyl Phenols and Alkyl Resorcinols—Part I.

N. V. Bringi, N. L. Phalnikar *and* B. V. Bhide, Poona.

In continuation of part I, o- & p- alkyl phenols and some of the alkyl resorcinols which are long known to have antibacterial properties, have been coupled with sulfa drugs such as sulfanilamide, sulfathiazole, sulfapyridine, sulfapyrimidine etc. The following dyes have been prepared.

Sulfanilamide is coupled with (1) o–n–propyl, (2) o–n–butyl, (3) o–n–amyl, (4) p–ethyl, (5) p–n–propyl, (6) p–n–butyl, (7) p–n–amyl, (8) p-n–hexyl and (9) n–heptyl phenol.

Ethyl resorcinol is coupled with (1) Sulfanilamide, (2) sulfathiazole, (3) sulfapyridine and (4) sulfapyrimidine.

n-butyl resorcinol is coupled with (1) sulfathiazole and (2) sulfapyridine.
n-hexyl resorcinol is coupled with (1) sulfathiazole and (2) sulfapyridine.

The above dyes have been tested for their antibacterial properties against M. Tuberculosis. It has been observed that they possess very little or negligible activity in the concentration 1 in 1000 as well as 1 in 500.

181. Azo Dyes from Sulfa Drugs and Halogenated Phenols, Resorcinols and Some of their Derivatives—Part II.

T. R. Ingle, N. L. Phalnikar *and* B. V. Bhide, Poona.

Combination of sulfa drugs with other substances having bactericidal properties has been a promising field for research.

This part deals with the dyes obtained by coupling sulfa drugs with the halogenated phenols and resorcinols which are known to have antibacterial properties.

Sulfanilamide is coupled with (1) o-chloro, (2) o-Bromo, (3) o-Iodo, (4) p-Chloro, (5) p-Bromo, (6) Tribromo-phenol, (7) Tribromo resorcinol, (8) Tribromo-resorcinol monomethyl ether, (9) Dibromoethyl-resorcinol.

Sulfathiazole is coupled with (1) o-chloro, (2) p-chloro and, (3) p-bromo phenol.
Sulfapyrimidines coupled with (1) o-bromo phenol.
Sulfapyridine is coupled with (1) o-iodo phenol.

These dyes have been tested for their antibacterial properties against M. Tuberculosis using Lowenstein-Jensen medium. Out of these the dyes from o-chlorophenol and sulfanilamide have been found to have some antibacterial property.

182. Studies in the Chemistry of Chromones—Part II. 6-Hydroxy Chromones.

T. R. Ingle, N. L. Phalnikar *and* B. V. Bhide, Poona.

In continuation of the work described in part I (*Abs. Proc. Ind. Sci. Cong.* 1948, III 36) the following chromones have been prepared by the interaction of 2 acyl hydroquinone, ethyl formate and sodium.

(1) 6 hydroxy 3 n-propyl chromone m.p. 119°C. (methyl ether m.p. 48-49°C.) (2) 6 hydroxy 3 iso-propyl chromone m.p. 190-191°C. (methyl ether m.p. 87-88°C.) (3) 6 hydroxy 3 n-butyl chromone m.p. 138°C. (Methoxy derivative m.p. 61°C.) (4) 6 hydroxy 3 n-pentyl chromone m.p. 146°C. (acetyl derivative m.p. 90°C.) (5) 6 hydroxy 3-n-decyl chromone m.p.115°C.

These chromones have been tested for their antibacterial properties on M. Tuberculosis. They completely inhibit the growth in the concentration of 1 in 500, but a slight growth has been observed in 1 in 1000.

183. Investigation of Some Methods of Determining the Glyceride Composition of Fats.—Part II.

V. V. MHASKAR *and* B. V. BHIDE, Poona.

For the estimation of different glycerides in liquid fats, Suzki, Yokoyama and Hahsi (*J. Soc. Chem. Ind.* Japan *30*, 849, 1927; *31*, 117, 1928), Sahasrabudhe and Kale, (*J. Uni.* Bom. *2*, 37, 1932) have used the method of bromination of gycerides and subsequent fractional separation of the bromoglycerides. The same method has been modified by Vidhyarthi and co-workers (*J. Ind. Chem. Soc.* 1940, *17*, 87-95).

The same method has been used in this work to estimate different glycerides in a known mixture of the following synthetic glycerides.

(1) Tri-linolein (2) Oleo-di-linolein, (3) Linoleo-diolein (4) Tri-olein.

The results obtained are discussed. Oleo-di-linolein and linoleo-di-olein have been synthesised for the first time.

184. Chemical Investigation of the Oil from the Seeds of Caesalpinia Sepiaria (Roxb).

V. V. MHASKAR *and* B. V. BHIDE, Poona.

The oil obtained from the seeds of Caesalpinia Sepiaria has been fully analysed. The following acids were found to be present. The percentage of the acids present are as follows :—

Palmitic acid 5.6 per cent.
Stearic acid 7.25 per cent.
(Probably) Lignoceric acid 0.5 per cent.
Oleic acid 23.5 per cent.
Linoleic acid 63.1 per cent.

185. Synthesis of γ (Substituted Phenyl) Δ^b Crotono Lactones.

V. K. PARANJPE, N. L. PHALNIKAR *and* B. V. BHIDE, Poona.

In continuation of the work of Shaha and Phalnikar (*J. Uni* Bom. XIII, iii, 22 (1944) 2 alkoxy toluyl crotono lactones and 2:5 di-alkoxy phenyl crotono lactones have been prepared with a view to throw further light on the observations of the previous authors. They have been characterised by their functional arylidine derivatives.

The lactones have been prepared from the corresponding 2 alkoxy 5 tolyl and 2:5 di-alkoxy benzoyl propionic acids. The follwoing lactones have been prepared.

(1) γ 5-methyl 2-ethoxy phenyl Δ^b crotono lactone.
(2) γ 5-methyl-2-propoxy phenyl Δ^b crotono lactone.
(3) γ 5-methyl 2-n- butoxy penyl Δ^b crotono lactone.
(4) γ 5-methyl 2-iso butoxy phenyl Δ^b crotono lactone.
(5) γ 5-methoxy 2-iso amyloxy phenyl Δ^b crotono lactone.
(6) γ 2:5 diethoxy phenyl Δ^b crotono lactone.
(7) γ 2:5 di-n-propoxy phenyl Δ^b crotono lactone.
(8) γ 2:5 di-n-butoxy phenyl Δ^b crotono lactone.

These lactones as well as some of their arylidine derivatives have been tested for their anthelmintic properties on earthworms. It has been observed that these lactones, in general, are not more toxic towards earthworms, which supports the observation of Shaha and Phalnikar (*loc. cit.*).

186. Chemical Investigation of the Resins obtained from the Seeds of Ipomea Muricata.—Part I.

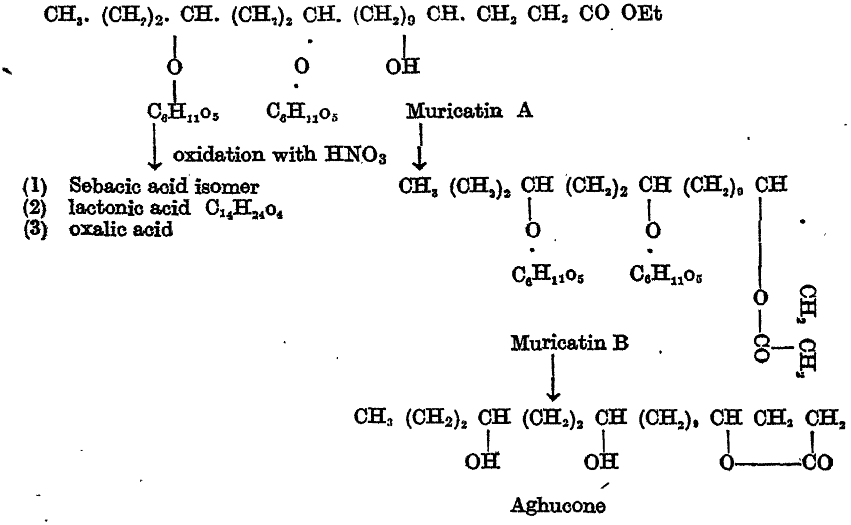
M. P. SINGH *and* J. D. TEWARI.

The seeds of Ipomea Muricata belonging to the natural order of Convolulacea has been reputed to be possessed with medicinal properties. On extraction with benzene the seed gave an oily substance which on standing separated into two portions, a viscous oil and a solid resinous mass consisting mostly of glucosides. The latter was however obtained in comparatively purer form by extracting the seed with alcohol and purifying the product thus obtained by partitioning in different solvents like petroleum ether, benzene and alcohol. In this way ultimately the resin was obtained as Muricatin A. This substance on oxidation with nitric acid gave three acids of the empirical formula, $C_{10}N_{18}O_4$ (m.p.116°-117°C) isomeric with sebacic acid, a lactonic acid $C_{14}H_{24}O_4$ (m.p. 98°-99°C) and oxalic acid.

Muricatin A on hydrolysis with alkali furnished a lactonic product, $C_{32}H_{58}O_4$, m.p. 104°-106°C which we have named Muricatin B. It crystallises in star shaped needles. Muricatin B on hydrolysis with acids gave an aglucone $C_{20}H_{38}O_4$ m.p. 53°-54°C, which is a pale yellow substance crystallising from ether in beautiful star like crystals.

The lactonic acid obtained from the oxidation of Muricatin A on being boiled with sodium bisulphite and subsequent acidification gave an acid $C_{11}H_{20}O_4$ m.p. 108°-109°C identical with undecandioic acid.

From the reactions described above the following structural formulae are suggested for the glucosides, Muricatin B and their degradation products.


CH3. (CH2)2. CH. (CH2)2 CH. (CH2)9 CH. CH2 CH2 CO OEt
O O OH
C6H11O5 C6H11O5
Muricatin A
oxidation with HNO3
(1) Sebacic acid isomer
(2) lactonic acid C14H24O4
(3) oxalic acid
CH3 (CH2)2 CH (CH2)2 CH (CH2)9 CH
O O
C6H11O5 C6H11O5
O CH2 CH2 CO
Muricatin B
CH3 (CH2)2 CH (CH2)2 CH (CH2)9 CH CH2 CH2
OH OH O CO
Aghucone

187. Dyes derived from Adipic Acid.

SADGUR SARAN BAIJAL *and* RAM DAS TIWARI, Allahabad.

Adipic acid has been condensed with various aromatic hydroxy and hydroxy-amino compounds like phenol, resorcinol, catechol, pyrogallol, phloroglucinol, meta-amino-phenol and meta diethyl-amino phenol. The properties and behaviour of the dyes obtained as a result of these condensations have been described.

188. A Note on Changes Brought about in Oils on Keeping.

ANAND LAL MISRA *and* RAM DAS TIWARI, Allahabad.

In view of the fairly divergent results obtained by previous workers (Godbole and others: *J. Ind. Chem. Soc.* 1929, *6*, 295; Katti and Puntambekar: *J. Ind. Chem. Soc.*, 1930, *7*, 221), the oil of caesalpinia bonducella had to be re-examined before starting the studies on the glyceride structure of the oil. While carrying on these investigations (which will be published later), we came across a sample of the oil from these seeds which had been extracted in these Laboratories in 1933, and hence it became of interest to make a comparative study of the freshly extracted oil and the oil extracted about 15 years back. The following table gives the comparative figures :—

		Fresh oil	Old oil
Acid value	..	7.1	29.6
Saponification value	..	186.5	184.0
Acetyl value	..	30.0	61.3
Hehner value	..	92.8	92.5
Iodine value	..	105.4	109.8
Rancidity	..	..	..

With the development of rancidity, the acid value of the oil has considerably increased. The amount of the unsaponifiable matter in the oils of the seeds of the Leguminosal family generally exceeds 1% but in the present case it is not sufficient to account for the high acetylvalue of the oil. This suggests the presence of some hydroxy acid, but no such acid has been reported by any of the previous workers. The acetyl value of the oil has increased on keeping, suggesting the increase of the amount of hydroxy acid. The quantitative study of the component acids of the two oils is in progress.

189. The Effect of Various Groups and Ring Complexes on Carbon-Tetrahedral Angle.

L. D. TIWARI *and* J. D. TEWARI.

We have described elsewhere (under publication) a general method for the synthesis of $\beta\beta$-substituted adipic acids. In this paper we have determined the first dissociation constants of the acids thus obtained from a consideration of the carbon valency deflection theory of Thorpe and Ingold. The first dissociation constants are as follows:—

		Dissociation constant
Adipic acid	..	3.7
$\beta\beta$-dimethyl adipic acid	..	50.6
$\beta\beta$-diethyl adipic acid	..	163.6
Cyclopentane I-acetic -I-propionic	..	44.7
Cyclohexane I-acetic I-propionic	..	41.6

Comparison of the above values with the dissociation constant for the corresponding glutaric acids indicates that the carboxylic groups in such adipic acids were comparatively nearer to each other in comparison to what they are in the corresponding glutaric acids, though it is just the contrary in the case of the unsubstituted adipic and glutaric acids.

190. Dyes derived from 4-Phenyl 2:3 naphthalene dicarboxylic acid.

R. K. KAUL, Allahabad.

4-Phenyl-2:3 naphthalene dicarboxylic acid was obtained in good yield from phenyl propiolic acid by refluxing with acetic anhydride and the acid so obtained was condensed with phenol, resorcinol, phluroglucionol, o-, m-, and p- cresols to give dyes which gave deeper colour than the corresponding dyes obtained from phthalic acid.

191. The Effect of Unsaturated Chromophores on Pyronine Dyestuffs.—Part IV. Dyes Derived fron 2:6 Dihydrophthalic Acid.

I. N. Dharam Dass *and* J. D. Tewari, Allahabad.

In continuation of our work on the effect of unsaturated chromophores on the colour of pyronine dyes, we have prepared dyes from 2:6 dihydro-phthalic acid by condensing the same with phenol, resorcinol, catechol, o-cresol, m-cresol, m-aminophenol and phloroglucinol.

192. Chemical Investigation of the Active Principles of Oldenlandis Biflora.

R. N. Chauhan *and* J. D. Tewari, Allahabad.

Oldenlandis Biflora (or Kshetrapartata, *Sans.*, Pittpapra, *Hindi,*) belonging to the family of Rubiceae was reputed to be possessed with some medicinal properties. On chemical examination we found that an alkaloid could be extracted from it which was obtained by extracting the plant with alcohol as a pale yellow coloured needles melting at 206°C and having an empirical formula, $C_{14}N_{19}O_3N$.

193. The Adsorption of Hydrogen and Carbon Monoxide on Fischer-Tropsch Catalysts:—Part I.

J. C. Ghosh, M. V. C. Sastri *and* K. A. Kini, Bangalore.

The adsorption of hydrogen and carbon monoxide has been investigated by means of a volumetric technique in the temperature range from 20° to 250°, on two kieselguhr supported catalysts, one containing cobalt, copper, thoria, ceria and the other having chromium oxide also as an additional promoter.

With both these catalysts, activated adsorption of the two gases has been observed, that of hydrogen exhibiting two maxima on the isobar. Carbon monoxide was adsorbed in larger volume than hydrogen. This seems to be the general rule with Fischer-Tropsch catalysts.

The rates of adsorption of the pure gases have also been studied at various temperatures and pressures. From the data obtained from these measurements, the respective energies of activation of adsorption have been calculated.

The incorporation of chromium oxide as an additional promoter increases the amounts of adsorption of the two gases and their respective rates of adsorption, while reducing their energies of activation of adsorption.

194. The Adsorption of Hydrogen and Carbon Monoxide on Fischer-Tropsch Catalysts:—Part II.

J. C. Ghosh, M. V. C. Sastri *and* K. A. Kini, Bangalore.

The adsorption of hydrogen and carbon monoxide from 1:1 and 1:2 binary mixtures of the two has been studied on the two cobalt catalysts mentioned in Part I of this series in the temperature interval, 25°C to 100°C. A thermal conductivity meter was employed to read the composition of the gas-mixture before and during adsorption. No reaction between the gases was detected at temperatures below 100°C., even on prolonged standing in contact with the catalysts.

In the case of the chromium-free catalyst, the adsorption of hydrogen is enhanced at all temperatures by the presence of carbon monoxide. The adsorption of carbon monoxide, however, is lower from the mixtures than from the pure gas, except at temperature above 97°C. The position is somewhat reversed in the case of chromium-promoted catalyst, on which the adsorption of carbon monoxide is enhanced and that of hydrogen depressed by the presence of the other gas.

It has also been observed that activated adsorption of either gas sets in at much lower temperatures in the mixtures than in the pure gases.

195. The Adsorption of Hydrogen and Carbon Monoxide on Fischer-Tropsch Catalysts.—Part III.

J. C. GHOSH *and* K. A. KINI, Bangalore.

Adsorption of hydrogen and carbon monoxide was studied on two nickel catalysts of the composition-nickel: thoria: kieselguhr ::100:18: 1000 and nickel: thoria: Chromium oxide: kieselghur :: 100 : 9 : 9 : 100 in the temperature range 0°-204°C.

As in the case of the cobalt catalysts, activated adsorption of both hydrogen and carbon monoxide was observed with these catalysts also, but the maxima of adsorption were found to lie at much lower temperatures. Further, the amounts of gases adsorbed were also greater.

Carbon monoxide was found to be taken up to a greater extent than hydrogen on these catalysts also.

The adsorption from mixtures could only be studied at 0°, because at higher temperatures hydrocarbon formation took place . At 0°, the presence of one gas suppressed the adsorption of the other.

196. Adsorption of Hydrogen and Carbon Monoxide on Synthetic Methanol Catalysts:—Part I.

J. C. GHOSH, M. V. C. SASTRI *and* S. VEDA RAMAN, Bangalore.

The adsorption of hydrogen and carbon monoxide, both from pure gases and from mixtures of the two gases, has been studied over a basic zinc chromate catalyst, prepared by reducing precipitated zinc ammonium chromate in a current of hydrogen at 400°C. With pure hydrogen activated adsorption sets in below 25°C. and the amount adsorbed increases steadily with temperature, reaching a maximum value at about 200°C. In the case of pure carbon monoxide, two maxima of activated adsorption have been observed, first at 52°C. and again at 250°C. From the rates of adsorption of the two gases, the activation energies have been calculated. From a mixture of the two gases containing two parts of hydrogen to one of carbon monoxide, hydrogen was preferentially adsorbed. Mixed adsorption could be studied only at temperatures below 30°C. as hydrocarbon formation became noticeable at higher temperature.

197. Adsorption of Hydrogen and Carbon Monoxide on Synthetic Methanol Catalysts:—Part II.

J. C. GHOSH, M. V. C. SASTRI *and* G. SANJIVA KAMATH, Bangalore.

The adsorption of hydrogen and carbon monoxide on a promoted catalyst containing copper, zinc, chromium, thoria and ceria, was studied. Activated adsorption of hydrogen sets in below 25°C. and the amount adsorbed increases with temperature even beyond 300°C., which is the highest temperature reached in these measurements. Activated adsorption of carbon monoxide starts at about 100°C. Adsorption from a mixture of the two gases could not be investigated with this catalyst as appreciable hydrocarbon formation was observed even at 25°C.

198. Adsorption of Hydrogen on Synthetic Ammonia Catalysts at Elevated Pressures.

J. C. GHOSH, M. V. C. SASTRI *and* H. SRIKANT, Bangalore.

A static volumetric method has been developed for the measurement of the adsorption of gases by solids at high pressures.

Employing this method, the adsorption of hydrogen on a promoted iron catalyst used commercially in the synthesis of ammonia, has been studied at pressures up to 50 atmospheres and at seven temperatures between 50°C. and 350°C. The results obtained indicate two types of activated adsorption: One occurring below 150°C and the other above 200°C.

199. Studies in Niobium and Tantalum—Part I, Lithium Niobate.

N. R. SRINIVASAN, Bangalore.

Extensive investigations have been conducted on the preparation of lithium niobate. Mixtures of niobium pentoxide and lithium carbonate were fused under a variety of conditions and the products analysed. The use of sodiun fluoride as a flux has been tried. It has been found that the niobates formed are hard, infusible and insoluble masses, though Henri Guitér (*Compt. rend. 216*, 518, 1943) reports that lithium niobate is easly fusible and soluble. A new 4:3 lithium niobate has been prepared by the double decomposition of lithium nitrate with purified potassium niobate. The niobate obtained is a slightly soluble white powder of the composition $4\ Li_2O.\ 3Nb_2O_5.\ 15H_2O$.

200. Studies in Niobium and Tantalum—Part II. Lithium Niobotartrate.

N. R. SRINIVASAN, Bangalore.

The niobotartrates of sodium and potassium have been described in a previous paper (Srinivasan, Indian Science Congress, 1948, Sec. 4. p.5.). Lithium also yields a similar complex. The Lithium niobate prepared *viz.* $4\ Li_2O.\ 3Nb_2O_5\ 15H_2O$ was reacted with tartaric acid and the products of the reaction separated by fractional crystallisation. Lithium niobotartrate has been obtained as a white powder. Analysis reveals the composition as $Li_2O.\ Nb_2O_5,\ (C_4H_4O_5)_2,\ 8H_2O$. The properties of this compound have been studied.

201. Studies in Niobium and Tantalum—Part III. Niobotartrates of Ca., Sr. and Ba.

N. R. SRINIVASAN, Bangalore.

The niobates of the alkaline earth metals are insoluble substances. Therefore the niobotartrates of these metals are prepared by double decomposition of a soluble alkaline earth salt with potassium niobotartrate. The niobotartrates of calcium, strontium and barium are obtained as sparingly soluble white powders. Methods have been devised for their analysis. The following compounds have been prepared and studied :--

$CaO.\ Nb_2O_5.\ (C_4H_4O_5)_2\quad 10H_2O$

$SrO.\ Nb_2O_5.\ (C_4H_4O_5)_2\quad 10H_2O$

$4BaO.\ 3Nb_2O_5.\ (C_4H_4O_5)_4\quad 16H_2O$

202. Studies in Niobium and Tantalum—Part IV. Tantalotartrates.

N. R. SRINIVASAN, Bangalore.

It has been found that Tantalum, which bears a very close resemblance to niobium in its chemical properties also gives rise to a new series of complex compounds called the Tantalotartrates. The reaction between potassium tantalate and tartaric acid has been studied. A potassium tantalotartrate of the comp osition $K_2O.\ Ta_2O_5\ (C_4H_4O_5)_2\ 9H_2O$ has been isolated and its properties studied. A similar sodium compound has also been prepared.

203. Estimation of Tartaric Acid.

N. R. SRINIVASAN, Bangalore.

A modified procedure for the estimation of tartaric acid by the potassium iodate method has been given by Unger and Haynes (*Analyst* 1946, *71*, 141,) and the reported results are high when small amounts of tartaric acid are involved. The method has been reinvestigated for small amounts of tartaric acid and a procedure recommended. Results within 0.5% error have been obtained. The method is applicable to tartrates.

204. A Qualitative Study of Flame Tests for Tin, Gold and Bismuth.

R. C. Mehrotra, Allahabad.

H. Meissner's blue mantle test for tin has been studied and it has been found that the colour of the mantle differs with the halide taken. The tin salts in presence of hydrochloric acid and zinc give a blue mantle, in presence of hydrobromic acid and zinc they give a green mantle whereas in presence of hydroiodic acid and zinc they give a yellow mantle. It has been further found that the test is interfered by the presence of sulphate, nitrate and fluoride ions.

Reactions similar to the above have been found to be shown by the halides of bismuth and gold and hence precaution is necessary not to mistake a mantle given by them for the presence of tin. As a result of these studies, a new sensitive flame test for gold has been described.

It has been shown definitely that the blue mantle given by tin cannot be due to stannic hydride as has been supposed. A mechanism has been suggested for the above flame reactions of tin, bismuth and gold.

205. Studies in the Technology of Shark Liver Oil—Part XIII. Selective Hydrogenation with Platinum and Palladium Catalysts.

P. V. Nair, T. A. Ramakrishnan *and* H. Sreemulanathan, Trivandrum.

Broklesby ("Marine Animal Oils") has indicated that, by a process of controlled hydrogenation, it may be possible to eliminate selectively the off-flavours of marine oils which are chemically accounted for by the less unsaturated substances. Hydrogenation was accordingly effected with concentrations of 0.1% and 0.2% of platinum and palladium catalysts at 120°C. Organoleptic tests revealed that complete elimination of fishy odour was brought about in 90 minutes with platinum while palladium took 60 minutes to achieve the same result. Loss of vitamin A to the extent of 25 and 20% occurred with platinum and palladium respectively. Such grievous loss of the vital nutritional factor renders these catalysts unsuitable for controlled hydrogenation.

206. Studies in the Technology of Shark Liver Oil—Part XIV. Selective Hydrogenation with Nickel Catalysts.

P. V. Nair, T. A. Ramakrishnan *and* H. Sreemulanathan, Trivandrum.

Finely divided nickel is a reputed catalytic agent for controlled hydrogenation reactions. We have employed this in three different forms in our experiments in the selective hydrogenation of shark liver oil. Raney nickel (0.2%) which has found extensive application both in research and in industry, brought about complete deodorisation in 60 minutes at 120°C., but the loss of vitamin A was 14%. Reduced nickel formate at 0.1% concentration effected complete deodorisstion in 150 minutes at 120°C., but here again the loss of vitamin A was 15%. These two forms were thus found to be unsuitable for selective hydrogenation.

Nickel loaded on Kieselguhr (1:1000) was found to give the most encouraging results. 0.25% concentration of this catalyst reduced the oil to deodorisation point in 45 minutes at 120°C., with a total loss of vitamin A of less than 7%. Higher concentrations tend to greater deodorisation at the same temperature, while at lower concentrations threshold of deodorisation is reached only very slowly.

207. Studies in the Technology of Shark Liver Oil—Part XV. The Hydrolytic Index as a Criterion of Purity of Oil.

P. V. Nair, T. A. Ramakrishnan *and* H. Sreemulanathan, Trivandrum.

In the part X of this series (*Proc. Ind. Sc. Cong., Abs.* 192, *58*, 1948) the authors have indicated the use of the "Hydrolytic Index" for the detection and estimation of the extent of adulteration of shark liver oil with groundnut oil in trade samples. This work has been extended to assess the degree of adulteration with other vegetable oils and fats, such as coconut oil, sesame oil and cow's ghee. It has been shown that the "Hydrolytic Index" can be successfully employed to get a fairly accurate idea of the percentage adulteration with any of these common edible oils.

208. Studies in the Technology of Shark Liver Oil—Part XVI. Mercuration of Deoxygenated Low Grade Fish Oil.

(Miss) K. Pankajakshy Amma, P. V. Nair *and* T. A. Ramakrishnan, Trivandrum.

In a previous part of this series (*Proc. Ind. Sc. Cong. Abs.* 193, *59*, 1948) the authors had reported the results of experiments in the halogenation of the deoxygenated low grade shark liver oils. Mercuration of the hydrocarbons was effected by refluxing with mercuric acetate in a solution of the oil in ethyl acetate, amyl alcohol or absolute alcohol. The percentage proportions of mercury in the product obtained in each of these cases was 12.61, 14.44 and 19.82 respectively. The insecticidal and germicidal properties of the substances are being investigated.

209. Studies in the Chemistry of Plant Pigments—Part I. Synthesis of some Anthocyanidins.

(Miss) T. Pankajakshy Amma *and* P. V. Nair, Trivandrum.

7–o–Benzoyl fisetinidin chloride and 3:3′:4′–trihydroxy–6–amino–flavylium chloride have been prepared by the usual methods of flavylium salt synthesis with a view to compare their properties and colour reactions with those of the pigments of jacaranda and *Thunbergia eracta*.

210. Antioxidants for Shark Liver Oil—Part XII. Minimum Effective Concentration of antioxidants.

P. K. Mathew, P. V. Nair *and* T. A. Ramakrishnan, Trivandrum.

The antioxidant activity of a large number of compounds both organic and inorganic have been reported in these series. The substances which proved to have substantially enhanced the induction period of shark liver oil have been selected and their minimum concentrations required to warrant stability for a reasonably long period of time have been ascertained. The minimum concentrations of quinhydrone, α–naphthol, propyl gallate and l-adrenaline have been worked out for the liver oils of both tiger and pristis, the best known species of the Travancore coast. Of the promising antioxidants, l-adrenaline was found to be the most effective, satisfying as it does all the requirements of an ideal antioxidant. Propyl gallate comes only second to l-adrenaline in this respect.

211. Antioxidants for Shark Liver Oil—Part XIII. Synergistic Enhancement of Antioxidant Actions.

P. K. Mathew, P. V. Nair *and* T. A. Ramakrishnan, Trivandrum.

Exploratory studies on the synergistic enhancement of the antioxidant activity of a series of combinations of substances have been carried out with varying concentrations from 0.01 to 0.1%. The different groups studied were :-

1. Quinhydrone and Hydroquinone
2. Quinhydrone and l-adrenaline
3. Quinhydrone and orthophosphoric acid
4. l-adrenaline and orthophosphoric acid
5. Propyl gallate and citric acid
6. Iso-butyl gallate and citric acid
7. l-adrenaline and l-ascorbic acid

Excepting the feeble activity of combinations of propyl gallate and iso-butyl gallate with citric acid, none of them showed any augmentation of activity.

212. Antioxidants for Shark Liver Oil—Part XIV. Relation between Iodine Value and Maximum Peroxide Value.

P. K. Mathew, P. V. Nair *and* T. A. Ramakrishnan, Trivandrum.

It has been reported that the maximum peroxide value reached in a given sample of shark liver oil is a function of its iodine value. The peroxide values have been found in the same manner as reported in these series. Various samples of oil with widely divergent iodine values have been chosen for study. The iodine values and the maximum peroxide values when carried out under controlled conditions fall in the form of straight line graph from which the maximum peroxide value which the oil is likely to develop can be computed from a knowlege of its iodine value.

213. Studies in the Technology of Shark Liver Oil—Part XII. Deodorisation of Shark Liver Oil with Fermenting Media.

P. K. Mathew, P. V. Nair *and* T. A. Ramakrishnan, Trivandrum.

The Ayurvedic system of medicine recommends the use of milk for purifying certain therapeutic products. Deodorisation of shark liver oil was attempted by washing with cold and hot milk. The improvement in smell of the oil after washing encouraged us to experiment with the action of fermenting milk on shark liver oil. The oil after 36 hours' agitation with fermenting milk was completely devoid of its fishy odour. Other fermenting media like toddy and cashew fruit juice have also been successfully tried. The physical and chemical constants remained unaltered. Further work to elucidate the mechanism involved in the process of deodorisation by fermentation is in progress.

214. Travancore Marine Oils—Part V.

P. K. Mathew, P. V. Nair *and* T. A. Ramakrishnan, Trivandrum

The physical and chemical constants of several samples of liver oils drawn at the Government Shark Liver Oil Factory, Trivandrum, from known species of sharks have been determined. A number of bulk samples were also examined. A wide variation of the constants including their vitamin content has been observed.

215 Stability of Vegetable Oils—Part I. Coconut Oil.

P. V. Nair, C. J. Philip *and* T. A. Ramakrishnan, Trivandrum.

Enhancing the keeping quality of vegetable oils is of outstanding importance for their prolonged commercial storage. Vegetable oils undergo rancidity changes if they are unscientifically expressed and stored. Being endowed with active natural antioxidants, these oils are not so readily oxidised as oils of animal origin.

Preliminary exploratory study as to the best method for appraising the degree of spoilage has been carried out. This relates to the dependence of Acid Value, Peroxide Value and the Oxidisability Value on the extent of rancidity. The Peroxide Value and the Acid Value are simultaneously followed to assess the spoilage. The Values obtained were in good agreement with organoleptic tests.

Coconut oil which undergoes ketonic rancidity has been carefully examined as to its keeping quality. The development of Peroxides is remarkably slow and this factor singly cannot be used for this purpose. Coconut oil to which 0.1% cobalt oleate (freshly prepared), an active pro-oxidant has been incorporated to induce violent peroxidation, was used as the control. The antioxidant activity of the following substances on coconut oil has been investigated.—

(1) Hydroquinone, (2) Quinhydrone, (3) Anthraquinone.

216 Travancore Marine Oils—Part V. Green Turtle Oil.

E. John Jacob, P. V. Nair *and* T. A. Ramakrishnan, Trivandrum.

The oil of Green Turtle (*Chelonia mydas*) is a body oil obtained sometimes abundantly from the Travancore coast. The oil is expressed by boiling minced turtle muscles and ladling off the top layer. This oil is of much therapeutic importance in cosmetic chemistry. Skin tonics made from this products are emollient in their action.

Two different samples of the oil were examined to study their physical and chemical characteristics which are given below:

	Sample I	*Sample II*
Specific gravity	0.9148 at 30°C	0.9168 at 30°C
Refractive index	1.4670 at 30°C	1.4690 at 30°C
Acid value	12	8
Iodine value	114	102
Saponification value	202.5	202.5
Reichert-Meissel	1.8	1.4
Polenske value	1.4	1.6
Titre point	24.8°C	24.8°C
Unsaponifiable matter	1.4%	1.6%

The solid and liquid fatty acids were separated by Twitchells lead-salt-alcohol method, and were found to be 26.7% and 73.3% respectively. This result was returned by both samples of oil.

Methyl esters of the solid and liquid acids were prepared, fractionated under reduced pressure and each fraction studied. It was found that turtle oil contained traces of C_{10} acids lauric, myristic, palmitic and stearic as saturated acids, tetradecenoic, hexadecenoic as satuarated acids, C_{18} and highly unsaturated acids such as C_{20-22}. But the C_{18} acid contained besides the oleic the highly unsaturated acid, Clupanodonic acid.

Ethical preparations like face-creams, glycerine soaps, unguents are in process of preparation from deodorised turtle oil. Selective hydrogenation as developed in this laboratory is being employed to yield odour free turtle oil.

217. Estimation of Small Quantities of Iron in Water.

V. Krishna Pillai *and* N. S. Varier, Trivandrum.

Though salicylic acid has been known to produce a violet colouration even with small quantities of ferric iron, it has not hitherto been used in the estimation of iron. Hence an attempt has been made to utilise this reagent in the estimation of minute quantities of ferric iron present in water. It was found that either a 2 percent solution in alcohol or a satuarated solution of the acid in 30 percent acetic acid would be enough to estimate colorimetrically quantities up to 0.1 part per million. The intensity of colour produced varies with different concentrations of iron. The effect on the colour, of change in the hydrogen ion concentration, influence of other ions, ageing effect and temperature have also been worked out.

218. Essential Oils of Travancore—Part II. Oil from Cloves Grown in South Travancore.

K. N. G. Nair, N. S. Varier *and* P. V. Nair, Trivandrum.

The physical and chemical constants of clove oil obtained from cloves cultivated in South Travancore were reported in a previous communication (Abs. *Proc. Ind. Sc. Cong.*, 1948). On analysis this oil has been found to contain eugenol, acetyl eugenol, a- and b-caryophyllene, furfural and methyl alcohol, the last two being found only in traces.

219. Essential Oils of Travancore—Part III. Oil from Travancore Nutmegs.

K. G. N. Nair, N. S. Varier *and* P. V. Nair, Trivandrum.

Myristica fragrans is grown as a garden tree in many parts of Travancore. Though the dried nuts find a ready market, there is no great industrial use for the material. The present work was undertaken both with a view to determine the characteristics of the Travancore oil and to explore the possibilities of its economic use.

The mature nuts yield 10.2% of an essential oil (moisture free basis). The oil gave the following constants :-

Sp. gr. at 30°C ..	0.8904
Acid value ..	0.119
Sap. value ..	5.43
Acetyl value ..	46.27
Index ..	1.4775

Further work on this oil is in progress.

220. Variations in the Hydrological Conditions of Sea Water at Trivandrum Beach During 1947-48.

V. Krishna Pillai *and* N. S. Varier, Trivandrum.

The intimate relationship between the occurrence of phyto plankton and the availability of nutrient salts has been established by many workers. But no data is available about the variations in the conditions of the waters of the Travancore sea coast during various seasons. With a view to fill up this gap, data are being collected by analysing weekly collections for density, hydrogen ion concentration, salinity, phosphate, nitrite and ammonia. Side by side with this the variations in the plankton intensity in this area as well as such of the physical conditions as rainfall, pressure, wind (velocity and direction) and temperature are being closely followed with a view to correlate them with the chemical data.

221. Oil from the Seeds of Sesbania Grandifolia

M. Narasinga Rao *and* R. Subbiah, Waltair.

A preliminary investigation into the nature of oil from the seeds of Sesbania Grandifolia (Papilionaceae family) shows low Iodine value (22.7), high Acetyl value (92.5) and high percentage of crystalline non-saponifiable matter (20%). Hence detailed investigation into the nature of constituents is of special interest, which is in progress.

Sesbania Grandifolia, member of the Papilionaceae family, is an erect tree and produces seeds containing about 10% oil. A search in the literature has shown that the study of oil from the seeds has not been made. Seeds are collected in Vizagpatam District, Madras Presidency, dried and powdered and extracted with carbon-tetrachloride. The yield is about 10%. The oil is a viscous, dark coloured liquid. The characteristics of the oil and the mixed fatty acids are given in the following table.

Table I.

	Sap. Val.	I. V.	Acety. val.	Acid-val.
Oil	205.5	22.7	92.5	15.0
M. F. A. (75%)	226.5	48.2	60.8	—

Non-saponifiable matter ....20% (colourless crystalline solid)

A few preliminary tests were carried out with the mixed fatty acids. The mixed fatty acids were brominated in ether at ice temperature, but no crystalline precipitate could be obtained. On oxidation with alkaline permanganate in cold, di-hydroxy-stearic acid could be obtained. The mixed fatty acids, on extracting with Petroleum ether, left a small amount of resinous matter.

Detailed investigations into the nature of the constitutents in mixed fatty acid in the usual manner and in non-saponifiables by Phthalic anhydride method (Chibuall *et. al.*) are in progress.

222. Microphotographs of Mercuric Chloride Crystals of Different Homologues of Pyridine Bases of Coal Tar Origin.

A. B. Ghosh *and* S. K. Chatterji, Calcutta.

Pyridine Bases consist of several homologues of Pyridine. By fractional distillation pure substances were separated. They are (1) Pyridine $+3H_2O$ (an azeotropic form of pure pyridine) B.P. 94°C, (2) Pure Pyridine B.P. 115°C, (3) Picoline B.P.135°C, (4)Lutidines B.P.150°-155°C consisting partly of a water soluble fraction and partlya water insoluble fraction. By the addition of 0.3 c.c. of 2% mercuric cholride solution to 1–2 c.c of these fractions, precipitates were formed. These were examined under microscope and the microscopic slides were then photographed with the help of a microphotograph camera. Their Morphological characters are as follows: (1) Pyridine and its azeotropic mixture showed long needle shaped crystals converging into an apex like the shape of broom sticks, (2) Picoline showed diamond shaped rather square plates crystals, (3) Lutidines: (i) water insoluble fraction showed star-shaped crystals, (ii) water soluble fraction showed as amorphous phase. The detection of these crystalline and amorphous precipitates formed the subject matter of a paper entitled as "Observations on Detection of Denaturants in denatured spirit" read at the 28th Indian Science Congress, Beneres, 1941.

223. Determination of Sodium Bicarbonate in Pharmaceutical Preparations.

A. BHATTACHARYA *and* I. B. BOSE.

It is a very common practice to incorporate or dispense sodium bicarbonate along with other alkali salts such as potassium citrate, sodium salicylate, etc., together with syrup and other drugs. The B.P. or B.P.C. methods even with their slight modifications for the estimation of sodium bicarbonate, could not be applied to preparations containing other alkali salts. In deep coloured solutions inconsistent results are obtained owing to the difficulty in reading the end point with indicators. The Hirch's method (*Analyst*, *73*, 160, 1948) for acidimetric titration of dark coloured solutions by using dithizone as indicator is not applicable to solutions containing other alkali salts.

The solution containing sodium bicarbonate and the alkali salts is evaporated and ignited when all alkali salts of organic acids are converted to carbonates. The total carbonates thus obtained are estimated by titration against standard acid. The other alkali salts are determined by independent methods and their equivalent quantity of acid is deducted from the total titre. The amount of sodium bicarbonate is calculated from the difference.

In order to test the applicability of this method the sodium bicarbonate contents of nine samples of varying compositions were determined by the proposed method, and also very cautiously by other methods whenever possible by removing the interfering elements and repeating the experiments for obtaining accurate results. In eight cases the actual sodium bicarbonate contents varied between 1 to 2 percent, and the difference between the results by two different methods (proposed and other) varied between 0.02 to 0.06 percent in seven cases, and 0.1 percent in one case. One sample was prepared with 1 percent sodium bicarbonate and the corresponding difference in this case was 0.04 percent. The results obtained are quite satisfactory. Therefore, this method may be safely used with advantage for the estimation of sodium bicarbonate in pharmaceutical preparations in the presence of other alkali salts and coloured substances for all routine purposes.

Pages 1 to 104 Printed by Kalipada Mukherjee at Eka Press, 210, Cornwallis Street, Calcutta.

SECTION OF GEOLOGY & GEOGRAPHY

President: Prof. C. Mahadevan, D.Sc., F.A.Sc., F.N.A.Sc., F.N.I.

A. GEOLOGY

1. Petrochemistry of the Trap Rocks of the Chitaldrug Schist Belt, Mysore State.

C. S. Pichamuthu, Bangalore.

In an earlier paper (Recs. Mys. Geol. Dept. Vol. 28, 1930) the author published a brief account of the petrography and petrology of three distinct occurrences of trap rocks found in the Chitaldrug Schist Belt—the Jogimardi, the Dark Hornblendic, and the Bellara traps. In this paper, the chemical analyses of these rocks are given and their petrochemistry discussed.

2. A Note on the Eurite dyke of the Giridih Coalfield.

Y. K. Agrawal and N. V. R. Subrahmanyam, Dhanbad.

The occurence of eurite dykes as pre-Damuda igneous intrusive rocks among the crystalline gneissic rocks of the Giridih Coalfield had been noted by Thomas H. Holland and Walter Saise in 1895, but there has been no further literature on these dykes. A recent visit to the locality by the above authors, has revealed some interesting characteristics of this dyke rock. One of the two eurite dykes traverses the felspathic gneiss near the southern boundary of the Giridih Coalfield at a point a little to the south of the junction of the Komaljore and Suni streams. Beside the dyke there are also intrusive pegmatites in this area. The dyke is definitely younger than the pegmatites as is shown by stringers of the former traversing both the felspathic gneiss and the pegmatites. Some of the eurite specimens are brecciated. A spring at this locality and slickensided rock surfaces also suggest faulting. A microscopic study of the eurite rock shows that the coarse grained granitic patches in the rock have all been derived from the pegmatites or the gneisses and are not the original constituents of the rock.

3. Studies on cleavage and joints in the Iron-ore series rocks, west of Chaibasa.

Ajit Kumar Saha, Calcutta.

The argillaceous and arenaceous rocks of the Iron-ore series to the west of Chaibasa are in a low grade of regional metamorphism. The oblique relation between the cleavage and stratification planes in these rocks has been brought out clearly in a stereographic projection of the two planes from the data taken at a number of places. Field observations show that, in general, cleavage got developed later than the folding. The orientation diagrams, prepared from the statistical study of quartz grain orientations in three specimens of quartzitic sandstones indicate that in these rocks the deformation is such as one would expect in the initial stage of regional metamorphism.

A study of these rocks further, reveals the presence of four distinct sets of joints. Two of these are more prominent and are of Mohr type, the obtuse angle between them being bisected by the direction of maximum stress. The other two sets are almost parallel and perpendicular respectively to the direction of stress, and thus are of Cloosian type.

4. The origin of the Waltair Highlands.

C. Mahadevan and N. Sataphathi, Waltair.

The origin of the Waltair Highlands which are formed of a thick red loam deposit around isolated hillocks has been tackled mainly by sedimentary petrographic methods co-ordinated by field work. Samples, collected from the red loam formations, sand dunes and a bed of a torrential stream, were mechanically and mineralogically analysed and the resulting data were graphically represented. The mineralogical composition of the samples discloses that the red loam is derived from the decomposed products of khondalites, charnockites and granites of the area. The size distribution of various heavy mineral grains of the samples reveals that the red loam is most likely of fluvio-aeolian origin. The available field data indicate very little possibility of the red loam to be a raised sand bank, as postulated by William King. The presence of eoliths and palaeoliths in the pebbly and gravelly horizons of the red loam formation shows that the formation is of late and post pleistocene age. Field and laboratory data indicate the possibility of red loam being formed by the cumulative work of wind and water.

5. The Geology & Petrology of Kondavidu Hill Range, Guntur District.

A. Narasinga Rao, Waltair.

The Kondavidu Hill Range in Guntur District, with the khondalites, charnockites (intermediate and basic varieties), leptynites and granites as the chief rock-formations was studied in its geological and petrological aspects by the author in detail in the field and laboratory. Systematic geological mapping of the area was carried out, with intense study of the field-relations.

The khondalites, with persistent strike and dip and bedded nature are usually confined to the western flanks of the range, while the basic charnockites, the more frequent of the two varieties traverse the khondalites as dykes and sills. The granites and leptynites form the main mass of the hills and the former show intrusive relationship with the khondalites and charnockites as these two are seen as enclosed xenoliths in the granites at various localities.

In the laboratory, detailed optic study of the micro-section of the various representative specimens, determination of pleochroic scheme, optic axial angle and extinction angle of the important minerals, and anorthite-content of plagioclase on the Federov's Universal Stage was carried out besides the micrometric analysis with the Dollar's integrating stage and chemical analysis by standard methods of rock-analysis of the chief types, namely khondalite, charnockites, granulite, leptynite and granite.

The petrochemical relationship were discussed after the method of Prof. Niggli.

The above investigations resulted in the following conclusions:

1. The khondalites are metamorphosed sediments, later granitized.
2. Leptynites and granulites are hybrids of granitic-khondalite intermixture.
3. Charnockites are post khondalitic but pre-granitic in age.
4. Intermediate charnockites are the products of interaction between basic charnockite and granite.
5. Mineralogical study revealed a positive hypersthene in one of the sections of the intermediate charnockite, with a 2V ranging from 69° to 77^{b}.

6. The Geology of the Basic Rocks around Jalwa Pahar, (Santal Paraganas).

S. K. Dey and B. Mukherjee, Calcutta.

The basic rocks with their metamorphosed equivalents occur in the Jalwa (Jalve) pahar region (24° 22' 30"N and 86° 39'E approx.) covering an area of 10 square miles with a general trend of NNE-SSW.

The important varieties are (1) meta-gabbro with or without olivine, with augite, calcic plagioclase and hornblende, the latter showing synantectic relation with plagioclase and augite or iron ores, (2) pyroxene granulite, (3) amphibolite and hornblende schists. At contact with granite gneiss, diopside and scapolite (with apatite and epidote) make their appearance.

Though in the field these rocks appear to have intrusive relation with the granitic country rock, petrographic examination reveals a discernible effect due to the granite, and a close examination in the field shows intimate veining by dykes and apophysis of the granite.

Zones of shearing noticed in the granite proves cataclastic effect after the consolidation of the granite. The metamorphism of the gabbros to amphibolites was due obviously to regional diastrophism prior to or just preceeding the granite intrusion. Later the granite has affected portions close to it by its exudation and heat converting them into scapolite bearing and diopside bearing rocks.

7. On the Geology of the Manganese-bearing Rocks of Garividi and Garbham, Vizag Dt.

G. Prabhakara Rao, Waltair.

This paper deats with the Geology, of the rock formations of Garividi and Garbham and with a special reference to the manganese-bearing rocks.

From the field and laboratory studies it is shown that the khondalites are original sediments now represented as quartzites, sillimanite-gneisses crystalline limestones and calc-granulites after intense-metamorphism. The occurence of sedimentary manganese-ores in the khondalites has also been shown, which are now represented as compact non-hydrated metamorphic ores after metamorphism. The khondalites are intruded by granites which has assimilated part or the khondalitic material as well as the managanese-ores resulting in a series of hybrid rocks the kodurites. A study of the managenese pyroxene from these rocks, by chemical and optical methods showed that it resembles Johannsonite in optical properties and stands unique by the presence of a high ferric iron. Analysis of the garnet from the kodurties at Duvvam showed that it was rich in grossularite, almandite and andradite. Since the formation of the kodurite, these were itensively altered by hydrothermal and meteoric water. As a result the apatite in certain places show gypsification in the margins and cracks. It is suggested that the action of sulphuretted waters brought a gypsification in the apatites and kaolinisation in the felspars, with a partial or complete distinction of the other silicates. The potash released during the decomposition of felspars was shown to have acted as a solvent in the released silica which was redeposited as opals and cherts. There is some amount of secondary enrichment in the ores by the action of solutions. The area contains large quantities of workable manganese-ores.

8. On some newly found patches of ultrabasic rocks near Chakradharpur.

S. K. Das Gupta, Calcutta.

In course of field work in December, 1946, the author came across some patches of altered ultrabasic rocks along the crest of densely forested ridges in the western sector of Seraikella State—about 6 miles S. W. of Chakradharpur City (B.N.Rly:):

These altered ultrabasic rocks occur as intrusive bodies in Mica-schists of Iron Ore Series and also as dykes in different formations nearby. These rocks are mostly represented by a greenish, fine grained, sheared Talc-Chlorite-Antigorite rocks but some of them particularly the dykes are coarse-grained and not sheared. Field evidences suggest that the coarser type represents a late intrusive phase and may be post-shear post Granite (Chakradharpur granite mass) in age.

From microscopic study, the following stages of alteration was traced out:—

(i) Serpentine rock (coarse-grained, non sheared) in the first stage, followed by-
(ii) Serpentine-chlorite rock.
(iii) Talc-chlorite-serpentine rock.
(iv) Talc-chlorite rock.
(v) Tough Potstone (mostly talc with appreciable chlorite) and
(vi) Soft Potstone or Talc rock.

It appears that the alteration was brought about by late hydrothermal solutions. The rock was, however, originally 'Peridotite' as seen by laboratory investigation.

Two mineral deposits are associated with the ultrabasic magma here *viz*-

(i) Pockets of Chromite that were formerly worked, and
(ii) Debris of Titaniferous Magnetite, the occurrence of which has been noted first by the author.

9. *An occurrence of cummingtonite-grunerite-anthophyllite-quartz rock in Kanigiri Taluk, Nellor district.*

A. P. Subramaniam, Madras.

A series of ridges striking NNE-SSW commencing from hill .275 a mile and half east of Pedda Alavalapadu (15° 19': 79° 38'), and extending southwards for about six miles, contain, interbanded with quartzites, quartz-granulites and quartz-schists, a greyish blue rock composed largely of bladed and acicular aggregates of a mineral which was suspected to be sillimanite. Detailed study of the micro-sections of these rocks under the Universal Stage, has shown these minerals to be amphiboles of the cummingtonite-grunerite and anthophyllite groups. The former display inclined extinction and multiple twinning of the lamellar type and have the following optical constants:

$$2V=+72^\circ \text{ to } 76^\circ \quad C \wedge Z \; 18^\circ \pm 2$$

while the latter display straight extinction with $2V=+76^\circ \pm 4$. Chemical analyses of these rocks show them to be rich in magnesia and iron, confirming the identity of the minerals established by optical study. Besides the amphiboles, these rocks contain quartz, a few flakes of muscovite and grains of pyrite and magnetite.

Chemical analyses of three specimens of cummingtonite-grunerite-anthophyllite quartz rock.

No.	SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	K_2O	Na_2O
1	51.68	14.40	12.80	3.98	1.98	13.78	tr.	0.58
2	51.48	14.60	10.44	6.16	2.74	13.18	tr.	0.54
3	50.88	17.30	9.50	2.90	1.58	15.44	tr.	0.43

10. The Rapakivi-like structure in the Epidiorite Injection gneiss of Dhanbad area.

N. L. SHARMA and Y. K. AGRAWAL, Dhanbad.

The authors record in this preliminary note the occurence of beautiful rapakivi-like structure in the epidiorite and injection gneiss of Damodarpur hillock near Dhanbad. The ovoids of felspar are usually circular or elliptical and may be as much as 5 cms in diameter. They are sometimes surrounded by felspar-quartz rims which may be up to 0.5 cm in width. The rocks containing these ovoids, especially the epidiorite, are associated with the olivine-bearing meta-norite and meta-dolerite of Dhanbad. A detailed study of the petrology of these rocks is under investigation. The occurence of the rapakivi-like structure in typically metamorphosed rocks of basic composition has not been recorded so far in India and the authors are of opinion that these structures are phenomena associated with the granitization and felspathization of rocks.

11. Para-amphibolites near Pahariagora, E. Manbhum.

S. SEN, S. RAYCHAUDHURI and B. MUKHERJEE

A series of amphibolites occur interbanded with, or as lenticular patches within, calc-schists and calc-granulites, forming a persistent band north of Pahariagora (E. Manbhum) in S. Bihar. The country rocks are sillimanite bearing schists and gneisses.

The amphibolites grade imperceptibly into the associated calc-silicate rocks and are without a facies belonging to the group. In general appearance and in mineral composition these amphibolites are quite distinct from amphibolites derived from norites that occur in other parts of the region.

These rocks consist of plagioclase and hornblende with little quartz, sphene, ilmenite and allanite (producing pleochroic haloes in hornblende); but the plagioclase is decidedly much calcic (An82) than one normal to an ortho-amphibolite, namely andesine.

Chemically too the rocks have distinctively high CaO and MgO but very little FeO and Fe_2O_3 and high alkalies with an excess of Na_2O over K_2O as contrasted with normal amphibolites. Even with such features the computed Niggli-value is plotted within the eruptive field of section Iv of his tetrahedron, a fact apparently against the para-origin. The difference in phase in the different parts of the rock are ascribable to the intrinsic variation in composition modified by addition of matter.

The hornblende fabric of the amphibolite was studied. The statistical fabric of the poles of the 110 cleavages give concentration along four zones on the *ac* plane.

An appreciation of the mineralogenetic factors would require a more detailed study of the chemical and mineralogical variation throughout the mass and a complete correlation of the farbic.

12. A Further Note On Petro-Geometry of Darjeeling Rocks.

S. RAY and S. SEN, Calcutta.

In a previous note to the Science Congress (1948) the quartzgrain farbic of two specimens from the garnet zone and one from kyanite zone in Darjeeling Himalayas were discussed. The present paper attempts a petrotectonic interpretation of the quartz fabric of sandstones from the Gondwana horizon of the same area.

The *ac* fabric of the specimen 84 (Gondwana sandstone) shows an imperfect girdle some 30° round *b* that has been broken up, the reconstitution has not, however, been to the degree reached in the higher metamorphic zones. Accordingly beyond the region of complete blank 30° round *b*, the distribution is somewhat haphazard up to the periphery. The same description applies to the second diagram (195) in which, however, the peripheral *ac* girdle is more distinct.

Thus, the five slides studied so far, can be arranged in order of increasing metamorphism as below:—84, 196 (low Cataclastic), 138, 104 (garnet zone), 121 (kyanite zone). The small *ac* girdle is less and less pronounced in the higher zones. This girdle, thus seems to be a predeformational fabric which has been broken up and progressively pushed towards the periphery by the orogenic stress.

It may be recalled here that Ingerson described a small (30°) *ac* girdle in undeformed Siwalik rocks. It appears that the Gondwanas and the older rocks had a similar pre-deformation fabric.

Further work is in progress.

13. Hypersthene-spinel granulite and related symplektites.

T. N. Muthuswami, Madras.

The paper deals with hypersthene spinel granulite (Hypersthene Spinellite) and garnet hypersthene cordierite, spinel and sapphirine assemblages in an abandoned quarry at Ganguvarpatti (Lat 10° 10 1/2′ Long 77° 42 1/2′) Periyakulam Taluk, Madura District. This quarry supplied touchstones about a decade ago.

The microscopic features of biotite, garnet hypersthene, cordierite, staurotite and sapphirine are given in detail. Symplektites of hypersthene-spinel, hypersthene-sapphirine and cordierite-sapphirine are recorded. Sapphirine is said to occur as a result of an influx of soda:-

1. as a diffused growth from various centres in hypersthene
2. as a reaction zone at contacts of (a) cordierite and hypersthene (b) cordierite and biotite
3. replacing spindles of spinel.

The mode of origin of the minerals is discussed. It is observed that the chemical composition of the hypersthene spinellite is abnormal and that symplektites of sapphirine and hypersthene have been seldom met with.

14. Petrological notes on Pakhals and associated rocks, Warangal dt. Hyderabad State.

C. Mahadevan and E. Venkayya, Waltair.

The Pakhals series consist of garnetiferous micacous phyllites, mica-garnet-staurolite schists, mica-garnet-andalusite schists, garnet-mica-kyanite schists, marbles, carbonaceous phyllites and quartzites. These are intruded by granites and basic rocks, blue quartz veins, and Pegmatites, along the southern margins producing contact effects such as baking, induration, and hybridisation with the development of contact metamorphic minerals. Hornblende-schists and ferruginous quartzites occur in proximity to and rarely in association with the Pakhal series. The paper records the petrology of the representative rock types of the Pakhals and associated rocks.

15. Notes on the hypersthene-granites and gneisses in the Dumka subdivision of the Sonthal Parganas in Bihar.

S. C. Chatterjee, Patna.

The paper deals with a group of hypersthene-bearing granites and granulitic gabbros which cut through the former occurring in different parts of the Sonthal

Parganas, such as near Trikut Pahar, and near Messanjor on the Mor river. The petrographical characters of the rocks and their field relations have been discussed in the paper and comparison made with other hypersthene-bearing rocks found elsewhere in India.

16. On the Recognition of "Dodguni Series" corresponding to the Middle Dharwars in Mysore.

B. P. Radhakrishna, Bangalore.

Near Dodguni, a small town situated 25 miles west of Tumkur a wide variety of Dharwar rocks are exposed in an ideal condition. The quartzites which are developed quite prominently show remarkably clear current bedding markings. On the basis of these markings the correct order of superposition of the beds and the tectonics of the area have been worked out.

The succession of the strata as established with the help of the current bedding markings is as follows:

Dodguni series

Banded ferruginous quartzites
Crushed sericite quartzites
Phyllites and Mica-schists
Limestones-Calcareous
Limestones-Dolomitic
Limestones-Manganiferous
Phyllites and Mica schists in parts replaced by Manganese
Amygdular hornblendic flows alternating with current bedded quartzites.
Quartzites-Current bedded
Garnetiferous mica schists
Amphibolites.

The succession commencing from mica-schists and phyllites in part replaced by manganese and ending on top with phyllites and mica-schists bears a close resemblance to the succession worked out for similar rock types in Gangapur and other places in the **Central Provinces. It is proposed** to call this rock series by the name *"Dodguni Series"* and keep it as a type succession to compare with the succession in the neighbouring Dharwar tracts in Mysore.

17. The Relationship of the Palnads and Cuddapahs in parts of Guntur Dt.

T. Madhusudhana Rao, M.Sc.

(Communicated by Prof. C. Mahadevan: Andhra University.)

The paper deals with the stratigraphic position of the Palnads in parts of Guntur Dt. The geological formations in this area consist of granites, conglomerate. quartzites, local sandstones, slatyshales and limestones. According to the field evidence and laboratory study the author has classified the quartzites and slaty shales of the area into two series consisting of two successive stages, namely Nullamalais and Kistna series of the Upper Cuddapahs. The Paland limestones have been studied in detail both on field and in laboratory and the author on the evidence classified them under 'Jummalmudgus' of the 'Kurnool' system. The conglomerate found near the hill 'Duvva-Bodu' to the north of Bhadrupalem, represents the unconformity between the Granites (Archaean) and the sedimentaries (Cuddapahs).

The microscopic study reveals that the Cuddapah limestones are crystalline and Paland limestones are cryto-crystalline, showing that the former have undergone appreciable amount of metamorphism while the latter scarcely exhibit effects of any metamorphism.

The Palnad limestones are rich in calcium carbonate with magnesium carbonate in negligible quantities. On a comparative study of the analyses of limestones it is found that the Palnad limestones correspond closely to the 'Bhimas', 'Sullavais and 'Vindhyan limestones, which are all homotaxial with the 'Kurnools'.

The presence of a pseudo-conglomerate(?) and the change in the amount of dip of the Palnad limestones represents a sort of time-gap or erosive-unconformity between the Palnads (Kurnool) and the underlying 'Kistna' quartzites of the Upper Cuddapah system. Thus the study of these 'Palnads' both in the field and the laboratory show that these are homotaxial with 'Kurnools'.

18. Correlation of the Bundelkhand granite, and associated rocks, from Mahoba area, Hamirpur District, United Provinces.

R. C. Misra, Lucknow.

The area under study lies between long. 79° 50′—79° 80′, and lat. 25° 15′—25° 20′, round about the town of Mahoba (25° 18′ N. and 79° 52′ E.) which is an important railway station on Jhansi Manikpur branch of the Great Indian Peninsula railway.

The imortant rock types found in the area are streaky gneisses (hybrid-gneisses), simple granites, quartz reefs and pegmatites, and dolerite. The hybrid-gneisses chemically and mineralogically and on field relationships are quite different from the simple pink granite, and have been formed by the soaking of the granitic juice in the older schistose rocks. After the granitic activity the residual magma has given rise to quartz reefs and pegmatites. The latest igneous activity in the area is in the form of a seven mile long dolerite dyke.

The presence of hybrid-gneisses proves not only the younger age of the Bundelkhand granite but its intrusive character. The Bundelkhand granite is, therefore, regarded post-Arawali in age contemporaneous with Singhbhum granite and the dolerite of the area has been correlated with the 'Newer Dolerite' of Singhbhum.

19. The relationship between Palnads and Cuddapahs in parts of Narasaraopet & Gurjal Tqs., Guntur Dt.

M. Krishna Murty, Waltair.

(Communicated by Prof. C. Mahadevan.)

The paper deals with the stratigraphic relations of the various formations with particular reference to the correlation of the Palnad beds. The area is geologically mapped, the field relationship and structure of the formations are carefully studied and laboratory investigations carried out on representative field collections. The rock-types of the area consist of granites of Archaean age, Phyllites, Quartzites and crystalline limestones of Upper Cuddapah age and the Palnad limestones. The Palnad and Cuddapah limestones, are analysed gravimetrically and volumetrically. The former have a high percentage of CaO with a negligible proportion of MgO whereas the latter contain much less $CaCo_3$ and $MgCo_3$ up to 10%. The Palnads are chemically and lithologically similar to Kurnools, Bhimas and Sullavais and differ from the Cuddapahs. Structurally the Palnads are disconformable with the Cuddapahs. No evidence either for faulting or inversion could be noticed in the area. From a consideration of all the available evidences, the Palnads are surmised to be Kurnools.

20. Microfossils and nature of coal in some Indian coal seams.

J. Sen, Calcutta.

An attempt has been made to establish a correlation between the organic constituents of coal, and types and nature of coal in bituminous seams of Indian Lower Gondwana Coalfields. For this purpose numerous samples have been examined from about 10 coal seams following the maceration technique.

The nature of coal is usually considerably influenced by the different plant components (woody elements, cuticles, spores etc.) and the species which have yeilded the seams. It has also been found possible to determine the specific plants from their microstructures from which the different components of coal, *e.g.*, Vitrain, durain and fusain, were derived. Similarly the approximate proportion of vitrain, durain and fusain contained in coal may be estimated from an examination of the maceration residues. It, therefore, appears that in future microfossil research will develop into a thoroughly practical method, and the data thus obtained may be useful to determine even the rank of coal. These correlations between the coal constituents and components have, however, serious limitations in some cases.

Usually vitrain contains least number of microfossils represented by a few speres, but durain contains numerous microfossils of different types, *e.g.*, spores, cuticles, other cell structures etc. Therefore, the relative amount of vitrain and durain in coal is determined by the quantity and quality of microfossils. Presence of too many cuticles always refer to too much of dull coal of inferior type. Fusain always contain abundant wood elements.

The following seams have been examined:—Ghusick, Satpukuria, Kushadanga. Lower Dhadka and Nega of Raniganj, Chope of Barakar and Karharbari of Karharbari stage. Bhadua seam of Karharbari and Laitryngew seam of the Cherra have also been incidentally examined. The analyses of most of the samples from these seams yeilded results as can be expected from the nature and type of coal of the test samples, *e.g.*, microfossil data shows that among the Raniganj seams examined vitrainised elements occur proportionately greater in Ghusick seam than in any other. Such possibilities are indicated above. The occurrence of the quantity and species of microfossils in different samples and their relative importance in the determination of the type and nature of all the coal samples from different seams have been discussed and described in detail.

21. The age of the Infra-Trappeans at Pangudi.

C. Mahadevan, & E. Venkayya, Waltair.

Outliers of Deccan traps occur in the neighbourhood of Rajahmundry and also near the village Pangudi, 12 miles west of the above town. The trap outlier is underlain south of the village Duddukur (4 miles west of Pangudi) by a series of fossiliferous grey, white and greyish white calciferous sandstones dipping in a S. E. direction upto 8° and constitute an important datum line to fix the age of the traps. Owing to its position below the traps, these sandstones are referred to as Infra-trappeans. These extend beyond Duddukur upto Gowripatnam towards the north and Devarapalle towards west and pass down without any recognisable unconformity into Tirupati sandstones dipping in a S. E. direction. The exact relationship cannot be made out in other parts of the field owing to thick sandy soil at the junction of the two formations, the age of the Infra-trappeans cannot be fixed definitely on account of the conflicting nature of palaeontological evidence. To co-ordinate and supplement the field data, representative specimens of the two formations were collected at regular intervals as required for stratigraphical correlation by heavy mineral suites. Petrographical studies are in progress, and a discussion embodying the results of the field and preliminary laboratory study are recorded.

22. Actinocyclina crassicostata from the Pellatispira-Bed (Upper Eocene) of the Surat-Broach Area.

B. S. Tewari, Lucknow.

This paper contains a description with figures of an *Actinocyclina* which was collected by the author from the Upper Eocene foraminiferal limestone occuring between Bodhan and Ghala, Surat-Broach region, Western India. It is shown that this is different from *Actinocyclina alticostata* Nuttal of Middle Kirthars and identical with *Actinocyclina crassicostata* Douville described from the Priabonian (Upper Eocene) of Europe. The fossil is being recorded for the first time in India and its stratigraphical importance is discussed.

23. The Physical and Chemical Properties of Vermiculite occurring at Appenhalli,—Hassan District, Mysore State.

C. S. Pichamuthu, Bangalore.

Vermiculite minerals have recently been identified in several parts of Mysore State. In this paper, the chemical, physical, and optical properties of the variety occurring at one of these localities in the Hassan District are described.

24. A New occurence of Mahadevite with further studies.

E. Venkayya, Waltair.

(Communicated by C. Mahadevan)

Books of mica collected by Krishna Crucibles Company from the Khondaltic tructs of the East Godavari District were sent for investigation of its properties. The new specimen is opaque in thick sheets with a bronze colour and lustre, highly fresh looking yielding thin transparent, tough and flexible laminae. When subjected to high temperature it does not show any appreciable changes in colour, toughness and flexibility. From the percussion figure the plane of the optic axes is found to be perpendicular to the clinopinakoid. The apparent optic axial angle calculated from Mallard's formula averages upto 13°. The B—refractive index amounting to 1.586 equals to that of Mahadevite.

The pleochroic scheme of the mica is as follows:

X = pale yellow
Z = Y = Light brown
Absorption:—Y = Z > X.

The mica shows a close similarity to Mahadevite. Analytical work to confirm the similarity of the new specimen with Mahadevite is in progress. Discussion and correlation of the optical properties and chemical composition of the new specimen and Mahadevite will be published shortly.

25. Pleochroic Haloes in Indian Minerals.

M. S. Doraiswami, Waltair.

Since 1907 when Joly conclusively showed the radioactive origin of pleochroic haloes, they have attracted the attention of scientists from all over the world. Yet in spite of this, all the anomalies found in them, the occurrence of over-exposed, bleached, normal, dwarf and emanation haloes do not appear to have been sufficiently studied to warrant a true interpretation. Pleochroic haloes have been reported from a number of localities.

in India, and important investigations have been carried out in India. Well-developed haloes in cordierite and bidalotite from the cordierite-gneiss of Mysore have been studied and preliminary measurements indicate the correspondence of calculated and measured values in the case of the new mineral bidalotite. Further investigations are being carried out.

26. On the Mica-Bearing Pegmatites of Tiruvur (Kistha Dt.) Madras.

N. Gopalakrishna Murty, Waltair.

(Communicated by Prof. C. Mahadevan).

The paper presents the Geology of Tiruvur area with special reference to the mica-bearing pegmatites. The deposits are situated on the plains of Tiruvur Taluq at different localities. The area is occupied by Archaean rocks consisting of garnet-sillimanite gneisses, mica-schists and quartzites. Charnockites, granites and pegmatites are intrusives into these formations. The pegmatite carries good books of mica and often occurs in association with the mica-schists.

Mica is of a fairly good quality. Its colour varies from ruby to colourless. But a green variety is also noticed. Books of mica vary in size from 66"—1' across and books of higher size (2—3 ft.) are also encountered as in the Gosavid pit. Mica is generally developed at the contact of the wall rock. Pegmatites traversing schists contain large quantities of mica. The assimilation of the mica-schist during the intrusion of the pegmatite has contributed to the formation of so much of workable sheet mica in the pegmatites. Mining in this area, though not highly encourging, is promising. If good deposits are encountered this area is likely to become a progressive mining centre.

27. Beach Sands of Vizagapatam.

P. Mahadevan and A. Sriramadas, Vizagapatam.

A systematic petrographical study of the beach sands of Vizagapatam coast was taken up to get an idea of the source and distribution of various heavy minerals more especially of monazite. Samples were callected along the beach and were subjected to mechanical analysis and heavy mineral separation. The resulting heavy fractions were divided into magnetic and non-magnetic parts using an electromagnet. The magnetic and non-magnetic parts were mounted on microslides and the percentages by number of different minerals were determined after identification. Computations have been made to obtain percentages of different minerals in different mechanical fractions and in the bulk samples. Extensive graphical representations have been made to elucidate the relations between the percentages of heavy minerals and sorting coefficients, distributions of heavy minerals in different size grades and etc.

The above study indicates that heavy minerals are concentrated at and near the mouth of the streams. The percentages of heavy minerals are more in finer grades. Monazite and zircon show close relationship. A moderate estimation shows that various minerals like ilmenite, monazite and zircon may be present in workable quantities in the black sand concentrates of the beach.

28. Geological Sketch of Kurupam Estate.

M. N. Deekshitulu, Puri.

Kurupam is an estate situated in the northern portion of Vizagapatam district Madras Presidency. Geological reconnaissance of this unsurveyed area was undertaken with a view to estimate its mineral potentialities. The Geological formations are Khondalites, mica schists, Charnockites, Granites and Gneisses. Granulites are regarded as hybrids between khondalites and granitic intrusions. Pegmatites that cut khondalites containing disseminated graphite are found to contain workable quantities of graphite as near Kesari, and those that cut the mica schists are found to be rich in muscovite as near Bodikonda and Chetaladanimetta. Semiprecious beryl (at Bodikonda), Kaolin (at Chetaladanimetta Tumbali and Kotapadu), and red ochre (at Tadikonda), Sillimanite (at Baidi Hill) are worth mentioning. From these observations it is concluded that a detailed survey followed by prospecting may reveal many workable deposits of the above minerals.

29. "The Prospecting and Correlation of Coal seams in Ramgundum area, Hyderabad State."

HAMZAH ALI, Hyderabad-Deccan.

The prosepecting work for coal in Ramgundum area was conducted in 1945-47. The paper discusses the relation of the coal seams with each other in the Baragar beds of the area prospected.

There are four ocal seams with average thicknesses of 18ft., 11ft., 25ft., and 15ft., respectively with in 3.4 miles of length.

A plan, two sections, 18 logs of boreholes are appended with eleven photographs illustrating the boring operations.

30. A Note on the Quartz Reefs in the Bundelkhand Gneiss, Gwalior State.

K. V. KRISHNAMURTY RAO, Gwalior.

Bundelkhand Gneiss covers a large area in the unions of Madhyabharat and Vindhyapradesh. In Gwalior State; (Madhyabharat) the Paraganas of Karera and Pichhore, Shivapuri District, and parts of Chatigaon and Pichhore Paraganas, Gwalior Gird District are covered by these Gneisses and Granitees. In the Neemuch Paragana, Mandsaur District Outcrops of Bundelkhand Granites are found in the outlying Villages of Palia, Nikumbh, Jharsadri, Peepalwas Etc.,

Quartz reefs having a general strike of NNE-SSW form a striking feature of the Gneissic Country. The strike varies from NNE-SSW to NE-SW. Six such parallel reefs are traced in this area. A few reefs running E-W are also found in Pichore Gird Paragana. They often rise to three hundred feet in height the entire rock being broken up by joint planes. These reefs often run for more than fifty miles, broken of course at intervals where alluvium covers the viens.

Economic minerals in reefs are Argentiferrous Galena in Aindher, Karera Paragana, Shivapuri District, Soapstone in Khurhaj-Rajnur Area, Pichore Paraganas, Shivapuri district, a large quantity of Amethyst, rose to smoky Blue colour, occurring as thin veins in the reefs all over, and crystal aggregates of clear and opaque quartz in druses at various places. Traces of copper stains on the Quartz crystals or as the Copper carbonate are also found in many places.

They seem to have intruded into the pre-existing gneisses, after the Par sandstones of early Bijawar (Gwalior Series) had consolidated. Clear evidences of the reefs intruding into the Par sandstones are found on the Par scarp near Sarayeepura Nihona, Bharas, Antri, Bhilowa and farther east. Many of these intrusions have been traced back to the main reefs, which are closeby. Whether or not, we can link up the origin of lead ores of Aindher with the intrusion of these reefs is a problem that has to be solved.

31. Outliers of Clay-Ironstone in the Nikubh Jagir., Gwalior State.

K. V. Krishnamurthy Rao, Gwalior.

Nikumbh Jagir is an outlying village in the Neemuch Pargana of Gwalior State, situated thirty-two miles NW of Neemuch Town. The area is comprised of Bundelkhand Granite overlaid by Aravalli Quartzites. Aravalli Shales and Slates, and a small patch of hornblende trap occur on the west The eastern boundary of the Jagir consists of a ridge and just on the boundary of the Jagir are three small outliers of Clay-Ironstone unconformably resting on the Quartzites. The beds are almost horizontal The clay which is greenish to white in colour is soft and friable. -The beds which are from 2 to 3′ thick are interbanded with those of Jaspery Ironstone which range in thickness from 2″ to 6″. The southern most outlier is approximately 20′ ×20′ ×50′. The other two are approximately 20′ ×15′ × 10′ to 20′.

The Quartzites underlying these seems to be later than the Aravalli Quartzites. In them are contained big rounded pebbles of the earlier Quartzites Judging from the nature of the deposit it is assumed that they belong to the Bijawar series, though ,it is not clear whether they can be correlated with the Clay deposits of Mandsaur.

32. Notes on the Occurence of Vermiculite in Mysore.

B. P. Radhakrishna, Bangalore.

Early this year Vermiculite was first noticed to occur associated with corundum-bearing rocks near Pavagada and a few other places in the Tumkur District A few more important occurrences of the mineral have subsequently come to light and the paper gives a detailed description of the now known occurrences at Pavagada and Nidavanda in the Tumkur District and Bageshapura and Channarayapatha in the Hassan District. It is pointed out that Vermiculite is of hydrothermal origin and has developed only at the marginal portions of basic and ultrabasic rocks in contact with the intrusive pegmatites and gneisses It is further indicated that in all the places examined it is either talc or hornblende which has altered to vermiculite and not biotite or phlogopite. The principal uses of vermiculite are furnished.

33. Alkali-rich clays from near Karekurchi and Janehar in the Tumkur District.

B. P. Radrakrishna, Bangalore.

Extremely fine grained clays white in colour, soft and greasy to the feel and coming off in the form of small lumps and cakes are soon exposed in some of the workings for manganese ore near Karekurchi and Janehar in Tumkur District The results of analysis of the clays show them to be rich in alkali containing as much as 8 to 9 per cent potash, a character somewhat unusual in clays The clays are described to be the residual alteration products of the underlying phyllites, the potash-rich character being due to the presence of minute particles of sericite. The extent of the clay deposits and the use to which the clays can be put are described.

34. Flotation of Chromite.

B. Sadasiva Raju, Bangalore.

Though gravity concentration methods are successfully adapted to beneficiate low-grade chromite ores, some interest has been shown in the possibility of utilizing flotation for this purpose. Flotation operation seems to offer particular advantages in the treatment of ores that must be finely ground to liberate the chromite, or those containing gangue minerals of high specific gravity. The low-grade chromite ore used in this investigation, however, does not contain any heavy gangue, except serpentine and other silicates. In order to depress this silicate gangue minerals, a chelate-forming organic compound, like Alizarin Red was used with oleic acid as a collector at a range between 4 and 6. The results were encouraging showing a recovery of 54% Cr_2O_3.

35. Determination of Feldspars in some Aphyric Deccan Traps.

N. A. Vemban, Calcutta.

The average composition of plagioclase in uniform grained Deccan Trap is given as Ab_1An_2 by H. S. Washington (1922). Fermor (1935) in his article on the Linga traps writes that 'the plagioclase is a labradorite somewhat more basic than Ab 1An 1' (P. 353). When the norms of the Linga traps studied by Fermor and of the average of the eleven analyses of the Deccan Traps (including one Rajmahal trap) given by Washington are examined, it is seen that the amounts of albite and anorthite are about equal to each other, corresponding to the composition of $Ab_1 An_1$. Thus a discrepancy is seen between the optical determination of plagioclase by ordinary petrographic method and the normative composition.

Bowen (1928 p. 141) attributes this discrepancy to the general tendency of petrographers to over-estimate the anorthite percentage by choosing the most basic part of the plagioclase, which, when zoned, is generally found in the interior of the crystal, and disregarding the quantitative importance of the outer rim. It will be seen, if a drawing is made to scale, that the outer shell need have only one-tenth the thickness of the whole crystal to form one-half the volume.

In this study the author determined on the Federov Universal Stage the core as well as the successive outer shells of the zoned plagioclase in four slides of aphyric Deccan Traps and drew Camera Lucida drawings of the crystals demarcating the several zones. The area of each zone was found out and the average An% for the crystal computed by allotting the An% of each zone according to its respective proportion.

Out of twenty determinations made, the averages in fifteen ranged between 46% An and 54% An and in five between 56% An and 58% An. A phenocryst seen in the Linga trap gave the highest average of 58% An. The highest limit of variation between the core and the outermost shell was 26% An. The maximum anorthite percentage for the core was 67% An and the minimum for the outer shell was 35% An. The average for all the twenty determinations was 52% An, corresponding closely to the normative composition arrived at from the analyses.

B. GEOGRAPHY

36. Landform Development in the Damodar Valley.

S. C. Bose, Calcutta.

River Damodar and its main tributary the Barakar form sunken basins north and south of the Hazaribagh Plateau. Three previously levelled surfaces occur in the valley, the middle one being the most conspicuous, being about 2000 feet high, and forming the surface of the plateau. A higher surface is noticed in the "Pats" near the source of Damodar and Lugu and Jhumra hills. Parasnath Hills is a gigntic monadnock between the two valleys. Other remarkable features are the plateau escarpments and table tops formed by the Supra Panchet sedimentaries. Landform development is discussed in the paper by dividing the area into a number of physiographic sub-regions. A block diagram has been specially drawn.

37. Plant Geography of the Damodar Valley.

S. C. Bose, Calcutta.

The paper deals with the natural cover found in the valley and its present condition due to deforestation. It gives various vegetational types occuring in the valley such as vast pure stands of gregarious. Sals (Shorea robusta) extensive palas jungles (Butea frondosa) Mahua glades (Bassia latifolia) and savannahs of Kash or Kese (Saccharum spontaneum), Bena or Khas (Andropogon muricatus) and Hogla (Typha elephantina). Possibilities of proper utilization of the forest wealth is discussed. A list of important plants and their uses is given.

38. "Water Resources of Pakistan".

Professor Maneck B. Pithawalla, Karachi.

It is generally forgotten by workers in diverse fields of human activity that the physical phenomena on the surface of the earth are related in many ways to the underlying geological features. Topography, Hydrography, dry and wet zones, earthquakes, seaquakes, floods etc., have much to do with the rocks of the earth. Actually all the land forms are the surface expressions of one underlying strata, evolved by nature for milleniums and aeons.

While considering the future prosperity of a State like Pakistan, the greatest possible emphasis will have to be laid on its *water resources,* especially in the western dry zone. That there will be a dearth of rich mineral deposits in the largely Tertiary rocks of Pakistan except petroleum and Tertiary coal cannot be denied. Pakistan's future industrialisation is bound to be affected on this account. Water will remain for long its most precious mineral and must be saved from running into the sea, the desert sands or the salt lakes at any cost. Every drop of water is needed for its development. Search for good water should precede search for minerals. Search for water-falls is also needed for Pakistan's potential hydro-electric power.

For this purpose all the development schemes will have to be considered *regionally* and *not provincially.* The river valleys will have to be treated as a whole and their tributaries to be trained first of all Contributions from glacier covers must be taken into consideration for the discharges of the rivers, particularly the Indus, the Chenab and the Sutlej. *Multi-purpose* projects will pay Pakistan in the long run and aerial surveys will have to be regarded as most profitable for hunting water currents. Researches into the navigability of the rivers should be undertaken side by side. Lastly, if the desert is marching northwards and eastwards, suitable steps have to be taken to prevent *sand-drift.*

39. The Agricultural Regions of Bihar.

P. Dayal, Ceylon.

An attempt has been made in this paper to divide the province of Bihar into four clearly defined agricultural regions, each of which is unified by some well-marked features which give it a distinctive quality and mark it out from the rest. These regions are:

1. The Wet Lowland 'Dhanhar' Tract, lying for the most part north and east of the Burhi Gandak river and dependent mainly upon rice, especially winter rice, grown almost without irrigation.

2. The 'Bhith' (including 'Diara') Tract, formed by the remaining portion of the North Gangetic Plain, and a small ribbon of lowland immediately south of the Ganges subject to deep and regular flooding during the rains. This is characterized by predominance of the 'rabi' harvest and the growth of the more valuable 'bhadai' crops which are here far more important than the rice crop.
3. The South Gangetic Irrigated Tract, comprising the whole of the South Gangetic Plain excepting the portion included under 2. Its chief distinguishing feature is its almost complete dependence upon irrigation for the success of its principal crops. Though rice is the predominant crop, a number of 'rabi' crops are also grown.
4. The Chota Nagpur Plateau Tract. The whole of the plateau forms one distinct region characterized by an essentially similar agricultural pattern throughout, namely rice in the valleys and on the terraced slopes, and maize, millets and a crop of oilseeds on the uplands. Such differences as exist are merely of degree and not of kind.

40. The Scientific Basis of Geographic Regionalism.

MANORANJAN CHAUDHURI, Calcutta.

Geographic regionalism is a definite remedy for many of our socioeconomic evils. The region is the unit area formed by aboriginal conditions of geological structure, climate, animal and plant life, reformed and partly re-defined by man according to his needs. Problems to be considered in regional planning include agriculture, drainage-basin development, land-use, soil-conservation, forming of new urban and industrial complexes and development of transporation facilities.

Regionalism is a dynamic concept. The type and extent of the region will depend upon the nature of its ties, that is whether the limits are primarily geographic or whether it is unified by economic resources or services, political organisation or racial affinities. A geographic region, thus may include within it a number of cultural and racial regions. The boundaries between regions are never graded; facts of human inter-course making them easier and accessible. Applied in a wider sense, regionalism has meant quite different things in different countries. Regional movement has meant economic cultural and political changes. Industrial planning presupposes regional planning. Among the examples of such regional planning bodies are the New England Regional Planning Commission, the Pacific North-west Regional Planning Commission and the Tennessee Valley Authority. The 21 economic regions (oblastis) of the Soviet Union are examples of scientific regional intergration of the country in place of 93 old provinces.

Regionalism is not sectionalism or separatism. The growth of the dynamic region signifies only the development of human relationship across the cultural, ideological and ethnic frontiers. In fact, it is the only important task for the present generation. A region-conscious world would avoid strifes and feuds and would automatically head toward a stable world organisation. The causes of conflicts among peoples is due to the fact that the process of political unification has taken place in generous disregard of geographic economic realities. Geographic regionalism applied in India would mean a total change in the economic and cultural landscape of the country. The paper, in a nutshell, discusses the theory of regionalism and reviews the recent trends of regional movement in different countries.

41. "The Rupnarayan Basin—A study in Riverine Geography".

PARBATI KUMAR SIRCAR, Calcutta.

The present paper is a regional study of the Rupnarayan Basin based on original field observations, correlating the distribution of physical and human .phenomena The Rupnarayan Basin, has been taken here to mean the natural basin of the Rupnarayan, excluding, however, the basins of the rivers, Silai and Dwarakeswar, which combine to form the Rupnarayan. Next to the Damodar, the Rupnarayan is the most important and problematic river of West Bengal, dominating the land and life of greater parts of the districts of Bankura, Midnapore, Hooghly and Howrah. The physical phenomena include a study of the hydrographic, climatic and edaphic environments, while the human phenomena embrace an interpretation of the occupation of the region and the distribution of population. The changing pattern of land utilisation through the last half century or so and the resulting shift in the populauion centres of gravity points to the regional disbalance of man and this on analysis proves to be due to the gradual decadence of the Rupnarayan. Congestion in the Silai and the Dwarakeswar and the uncontrolled discharge of the Damodar through its spill channels into the Rupnarayan bring in severe floods with roughly a three-year interval. The disturbance in the smooth river regime has all the more expedited due to human interference and a widespread maladjustment has set in between the soil and the sons of the soil. Hence solution of the problems facing the farmer lies in the solution of the river problem, by introducing the modern methods of river training.

42. The Godavari Basin—A geographical analysis.

K. BAGCHI and S. DAS-GUPTA, Calcutta.

The paper analyses the geomorphic and hydrological elements of the Godavari Basin. The resource-potentiality of the area has also been assessed. Particular attention has been given to the scope and possibility of the multi-purpose development of the Godavari river. The paper is profusely illustrated with cartograms, maps and blocks.

43. A Regional Survey of Shahabad District.

R. P. SINGH, Ranchi.

The paper deals with the regional survey of the district of Shahabad which is enclosed by the Rohtas hills in the south and the rivers Ganges, Sone, and Karamnasa on the other three sides. The district falls into four regions; the Hethar or lowland, Denar Bharki or the land between the Chausa canal and the Karamnasa, Dakhin or south, and the Pathar or plateau. The relief features of the district, its soils, climate, crop production, and distribution of population have been fully discussed in relation to human occupation. The problem of better utilisation of the land and prospects of industries have also been discussed.

SECTION OF BOTANY

PRESIDENT: M. S. RANDHAWA, M.Sc., I.C.S., F.N.I.

Cryptogamic Botany and Plant Pathology

1. Sea-weeds of Baroda Coast.

S. T. MOSES, Baroda and T. V. R. PILLAY, Okha.

Sea-weeds are abundant in Okhamandal and Kodinar areas of the Baroda State. Experiments in the past to a wrong assessment of sea-weed economics due apparently to mistimed visits, for weeds which are in profusion and in bloom in December and January die and disappear by July or even June. Occurrence of the edible sea-weed *Ulva lactuca* and useful algae like *Gelidium*, *Gracillaria* and *Sargassum* prove the economic possibilities of the investigation of sea-weeds of the coast. For even *Zostera* the abundant seagrass, use is found today elsewhere, in these days of refrigeration. The ecological set-up of the various genera and species is given with some details of habitat. So far 35 genera and 48 species were identified. Among these are included 3 species of Phanerogams. The work is proceeding. A check list is given:—*Microcoleus, Enteromorpha, Udotea, Caulerpa, Ulva, Halimeda, Amphiroa, Acetabularia, Codium, Padina, Sargassum Dictyota, Dictyopteris, Ectocarpus, Hydroclathrus, Colpomenia, Leathesia, Meristotheca, Chrysomenia, Gelidium, Gracillaria, Hypnea, Leveilla, Rhodymenia, Nitophyllum, Polysiphonia, Champia, Laurencia, Cryptomenia, Chondria, Coralline, Lithothamnium, Helophila, Cymodocea and Zostera.*

2. A Choanephora disease of *Dolichos Lablab*. L.

Q. A. AHMED, Dacca.

An undetermined species of *Choanephora* was observed by the writer in the University Botanical Garden, Dacca, on *Dolichos lablab* causing a dry rot and ultimate shedding of the leaf after reducing it to a blackish crumpled mass.

The fungus was observed in the later part of August and at the time of writing (21. 10. 48) is still continuing growth. On the infected leaf, profuse white stiff conidiophores 2 to 2.5 mm. in length can be seen bearing the black conidia. There is no appreciable enlargement of the primary stalk of the conidiophore at the point of origin of the conidia-bearing branches. Both large and diminutive pendant sporangia have been found to occur along with conidiophores in nature and in culture media. The columella tends to be globose. The sporangiophores are ovoid to fusiform with a cluster of very fine radiating hairs at both ends, but are not striate like the conidia. The conidia are also ovoid to fusiform in shape. Intercalary thick-walled chlamydo-spores are found to occur in culture media. Further work is in progress. The available literature gives no record of the fungus causing a disease on *Dolichos lablab* in India.

3. Production of Antibiotic Substances in Soil by the Method of Soil Treatment.

Four samples of rich garden soil were treated with the following organic substances and incubated at 30° C for varying periods of time:—Dextrose 0.4%, Peptone 0.25%, Oat straw 2% + $NaNO_3$ 0.2%, Dried blood fertiliser 2%, the figures representing w|w. During incubation, counts of micro-organisms were taken at intervals of 2—4 days and soil solution and extracts (alcoholic and ethereal) were prepared. These were assayed against four test organisms showing marked inhibitory properties, while the controls remained ineffective. The changes in the character of the soil microbial population as a result of treatment probably played an important role in inducing toxic condition in soil.

4. Effect of Tyrothricin on Nitrogen-Fixing (Non-Symbiotic and Symbiotic) Soil Bacteria.

Three strains of *Azotobacter* and five strains of *Rhizobium* were grown at 30°C in N-free mannitol phosphate media containing varying amounts of tyrothricin. The numbers of survivors were determined at intervals varying from 3-24 hours for 4—6 days. It appears from the results obtained that all strains were inhibited initially and that there was specificity of strains amongst susceptible organisms towards the antibiotic substance.

5. A truffle (*Tuber sp.*) from Kodaikanal Hills (Madras).

S. R. Bose, Calcutta.

In August 1948 I received some specimens of truffles from Kodaikanal hills (Madras); the ascocarp is about 4 cm. long and oval-shaped with warty scales on the outer surface; ascospores are brownish, globose with diameter 10-12 μ, spore-wall distinctly warty, ascospores (2-4) lying enclosed within clavate thin walled asci. This *Tuber sp.* in a rare find for India. There is only one previous record of truffle from India, *Tuber indicum* Cke. and Massee in "Himalayan truffle, 1822" listed in 'Fungi of India' by Butler and Bisby; it was collected by Duthie in Mussoorie hills.

6. Horse—hair Fungus from Bengal.

S. R. Bose, Calcutta.

The horse-hair fungus represents the mycelial stage of a *Marasmius* usually named *Marasmius equicrinis* Mull. I have collection of such cords of mycelium from Sunderbans in 1921 and 1925 on leaves and branches of *Heritiera minor* ('Sundri trees), from Chittagong (Chandraghona Kaptai Forest) in 1921 on bark of branches of *Dalbergia sisoo* ('Sisoo' trees), from Berkuda Island, Chilka Lake (Madras) in 1922 on dead and dry leaves, from a forest-area close to Calcutta in 1937 on dead leaves and twigs and from Singapore in 1927 collected by Mr. M. R. Henderson on dead branches and leaves. The Bengal specimens are rhizomorphs of *Marasmius equicrinis* and *M. pangerangensis*, both determined by late Dr. G. Bresadola of Italy. The cords of mycelium are black and tough, they look like black horse-hair . The cords run from branch to branch in forests, hanging in festoons from upper branches and remaining attached to leaves and stem by small brown discs. The whole course is random and aerial. Fructification appears in rainy season on forest beds when the tangled mass of leaves and twigs with the cords happens to fall to the ground. The fungus is not parasitic but epiphytic, it causes no damage to host trees. Petch has given a detailed description of the fungus with figures in his book on The Diseases of the Tea Bush, 1923, pp. 83-85. The fungus grows on various shrubs and trees in the forests. It is common in the eastern tropics. Recently (F. J. Seaver, *Mycologia Vol.* 36, 1944) it has been reported from North America, Louisiana, scrub oak forest near S. W. Evans, the hanging cords were encountered by American soilders during their manoeuvres; they used the black cords for sewing buttons on coats and overcoats.

7. Some common ferns of the Darjeeling District.

K. Biswas and Surinder Singh, Sibpur.

The present paper contains descriptive account and observations on the ecology and altitudinal distribution of some of the common ferns of the Darjeeling District. The study is restricted at present to some 50 common species occurring between the elevation of about 4,000 and 12,000 feet.

8. The structure and life history of *Anisogonium esculentum* Presl.

T. S. Mahabale and Tripiti Biswas, Bombay.

Anisogonium esculentum Presl. is an interesting Asplenoid fern growing profusely as a semiaquatic or terrestrial plant in marshy places and fields below waterfalls at Mahabaleshwar and other places in the Bombay Presidency. The anatomy of this species has been worked out which in general agrees with that of Asplenoid ferns in having a dictyostelic rhizome, leaf trace with two strap-shaped bundles etc. The stolon shows a broad more or less semicircular siphonostele, protoxylem lying at the two ends of the core. The most important feature of the plant is a variety of the ways in which it reproduces vegetatively by the formation of stolons, buds arising in the axils of leaflets and rachis, margin of pinnules and on roots.

A study of the different modes of vegetative propagation and structures involved in them is in progress.

The spores germinate in about 6-7 days form prothalli in 1½ months in culture. The prothalli are multilobed, irregular, small, 0.1—0.2 cm. in diameter showing varied behaviour in germination. Their development and adult form generally resemble those of *Actiniopteris*, but mostly they are without any cushion. There is a plurality of meristematic cells at the margin resulting in multilobed structure lying in more or less the same horizontal plane. The antheridia are normal. Some of the cells at the lower end of the prothallus show collenchymatous thickenings. No archegonia have so far been noticed even in large fully formed prothalli.

9. Prothallus of *Lygodium flexuosum* Bedd.

T. S. Mahabale and N. Kulkarani, Bombay.

Two species of *Lygodium* namely, *L. flexuosum* Bedd. and *L. microphyllum* R. Br. are found in the Bombay Presidency, the former being commoner than the latter.

The studies on the germination of spores revealed that the spores are viable as soon as they are formed and germinate in a normal way. They are viable for about 6 to 8 months.

The adult prothallus of *Lygodium flexuosum*, growing wild in nature, is a large, broadly cordate (breadth varying from about 4 mms. to 1.2 cm.), thin and delicate structure having more or less symmetrical lobes. The apical notch is very narrow and prominent. In most of the cases the two lobes of the prothallus overlap each other at the anterior end, leaving a small unoverlapped portion towards the centre. The margin is entire. The cushion is thick and prominent—the thickness being about 1 to 2 mm. On the posterior part of the cushion are many unicellular smooth rhizoids.

The cells of the prothallus are large, closely packed, hexagonal with their longer axes elongated in the radial direction. Each cell is full of protoplasm having numerous chloroplasts. About 2 to 3 layers of cells below the margin are irregular and have wavy cell walls. Curiously enough a few club-shaped unicellular glandular hairs pointed towards the apex of the prothallus are noticeable on the margins of lobes, especially towards the anterior side. The prothallus is bisexual bearing archegonia on the cushion and the antheridia on the lateral sides and its posterior part, mixed with the rhizoids. Each archegonium is embedded in the tissue of the thallus, with its neck slightly protruding. The antheridia which are even found to be present on the thallus after fertilization, dehisce by the overthrow of a small circular opercular cell as in other Schizaeaceae.

The sporophyte arises from any part of the cushion and forms the first leaf which is not lobed. The young embryonic leaf is covered with two-celled hairs not very different from those on the prothallus. Studies on the development of the spores and embryo are in progress in the two species.

10. Prothalli of *Cheilanthes farinosa* Kaulf. and *Tenuifolia* Sw.

T. S. Mahabale and J. J. Shah, Bombay.

Cheilanthes is an important member of the advanced Gymnogrammoid ferns and is represented by ten species in India of which three occur in the Bombay Presidency. They are all xerophytes-highly specialised in their anatomical structure. The exact affinities of the genus are uncertain, its nearest relative being considered to be *Gymnogramme* by some, *Pellaea* and *Notholaena* by others and *Adiantum* by still others. The reasons for this variety of opinions lie in its morphological features such as scales and glands as those in *Pellaea* and *Notholaena,* the solenostelic rhizome, waxy coating and acrostichoid dissolution of the sorus as in *Gymnogramme,* and the submarginal semicircular sporangia seated on distal ends of veins protected by recurved leaf-margin as in *Adiantum.* In view of these diverse characters it was thought worth-while to investigate the prothalli of *Cheilanthes farinosa* and *tenuifolia* Sw. growing wild in Bombay Island. The spores were successfully germinated in the latter species but not in the former. Prothalli of both were obtained in nature.

The adult prothalli of *C. farinosa* are fairly large, cordate, the notch being deep at both the ends. They are dark green, 0.3 to 1 cm. in diameter. The cushion is thick and produces tubers should there be no fertilization, by the prolongation of the anterior end. Such prothalli are generally perennial, large and stout. The archegonia are scattered over the tuberous swelling of the cushion or its prolongation. The sporophyte is formed near the anterior end. The embryonic leaf is simple and bears numerous wax glands characteristic of the species. In shape, appearance and perennation the prothallus greatly resembles those of species of *Anogramma, Gymnogramme* and liverworts like *Fossombronia.* In some large prothalli multicellular, brown, scales were seen arising on buds below meristem strongly indicating apogamy.

The prothalli of *C. tenuifolia* grow on hard barren rocks at Sion near Bombay. They are also cordate but not deeply notched. They are 0.2—0.3 cm, in diameter and dark in colour. The cushion is small and elongated. The lobes stand more or less erect in their natural habitat. The archegonia are formed at the anterior end of the cushion, the antheridia spreading on the posterior part.

The spores germinated in about 10 days and formed prothalli. On the basis of the prothallial characters the genus seems to be a near relative of *Gymnogramme* and *Adiantum*.

11. Prothallus in the genus *Nephrolepis*.

T. S. Mahabale and S. R. Javalgekar, Bombay.

A study of the sporogenesis in *Nephrolepis exaltata, volubilis* and *acuta* by one of us (T.S.M.) and Gorji revealed that there are 42 chromosomes in *N. exaltata* and that there are no deviations from the normal cytogenesis in these species. A natural corollary to this was to study the behaviour of spores in culture and to get the prothalli. Several attempts to germinate the spores in *N. exaltata* however failed under laboratory conditions but succeeded in *N. acuta* and the prothalli were formed. The prothalli are 1.5—2 cm. in diameter, thin, and cordately lobed, the lobes being more flattened than in a typical heart-shaped prothallus. They bear numerous reproductive organs generally on the same prothallus but in some only antheridia appear in culture. Two remarkable features of these prothalli are: (1) the presence of small hairs on the margin and on the upper surface, similar to those noticeable on the young leaves of the vegetative buds arising aposporically in the place of sporangia; (2) antheridia borne on a number of filaments emerging from the marginal region of the prothallus in small prothalli.

The antheridia are of the normal polypodiaceous type spread over the lobes of the prothallus.

Although no prothalli were obtained in culture in *N. exaltata* they were obtained this year on Sion hills near Bombay where the species grows wild. These also are typically cordate, bear both antheridia and archegonia in the usual manner but the cushion is very small. The young sporophyte has a bilobed leaf with highly conspicuous hydathodes and clavate hairs. This confirmed the earlier expectation about finding the prothalli of this species.

Prothalli in a third species *N. paucifrondosa* d'Alm. which is endemic in the Western Ghats were obtained growing epiphytically in the pockets of soils on trees on which the species grows. The prothallus is cordate, about 0.2 cm. in diameter with flat thin lobes, but is extremely delicate and transparent.

12. On a new species of *Pucciniastrum* from India.

J. Sen, Calcutta.

A new species of leaf rust which belongs to the genus *Pucciniastrum* Otth. was found widely affecting *Abies pindrow* Brandis in Kulu Valley. The material under investigation was collected between January and February, 1947. The leaves are seriously affected and as such heavy damages may be expected. Pycnial, and telial stages are not present. The aecidia are somewhat erumpent, small and numerous on the leaves. Peridium delicate forming compact cyst-like units. Spores hyaline, smooth and thin-walled, usually rounded, sometimes ellipsoidal, measuring 5-7 μ.

In India the species of *Pucciniastrum* chiefly occur on broad-leaved species. This *Pucciniastrum* therefore is not only a new species but has also acquired a new host in India. But *P. goeppertianum* (J. Kuhn) Kleb. and *P. pustulatum* (Pers.) Diet. have already been reported to occur on *Abies* in America.

The author desires to thank Mr. H. P. Pande for the material and Dr. George B. Cummins for helpful suggestions.

Phanerogamic, Taxonomic and Geographical Botany

13. The Flora of Pareshnath and the neighbouring hills.

K. Biswas and M. A. Sampath Kumaran, Sibpur.

Sufficient information is available on the vegetation of the Pareshnath Hills but a few interesting plants which form what may be termed as a more less relic vegetation on the summit of this highest mountain bordering Bengal and Bihar, bear a striking similarity to some of the plants found at similar elevation over the Sikkim Darjeeling Himalaya.

The geographical position of the Pareshnath range, their geology and climatological data recorded from time to time by various workers have thrown some light on the question of vegetational affinity with the sub-Himalayan regions.

The authors have discussed the floristics of this interesting group of vegetation in the light of their field studies, examination of herbarium materials and existing accumulated data.

14. The Indian Dioscoreas and their importance on dietary.

K. Biswas and M. A. Sampath Kumaran, Sibpur.

Tubers of the edible Dioscoreas are used as food for centuries in the East. In the voluminous monograph, "An account of the genus Dioscoreas in the East" Parts I & II by David Prain and I. H. Burkill (published in the *Annals of the Royal Botanic Garden,* Calcutta, *Vol. XIV,* 1936 & 1939) the Indian Dioscoreas have been dealt with in a masterly way. The authors, however, consider that there exist further scope of more detailed studies on the edible Indian species of Dioscoreas from systematic, ecological, nutritive and horticultural aspects. Durign these days of scarcity of food all possible sources for increasing human diet needs careful examination and the authors hope, the information contained in their paper will have considerable bearing on the problem of "Grow More Food".

15. Notes on the distribution and systematic position of Indian *Diptero-Carpus.*

K. Biswas and P. V. Bole, Sibpur.

The Indian *Dipterocarpus* do not seem to have received the attention it deserves either by foresters or botanists. In the present paper the systematic, the taxonomy, the ecology, the distribution and the economic importance of the species under this genus have been treated. There are 73 authentic species recorded. Of these, the east claims 23 only. Of these again, 2 occur in South India, 5 in Ceylon and 16 in the Lower Bengal extending down to South Burma where the *Dipterocarpus* forms one of the important constituents of the trees forming the overhead canopy in the rain forests.

16. The embryo sac of Podostemaceae.

B. A. Razi, Bangalore.

Several authors, Magnus, Went, Chiarugi and Hammond have demonstrated a reduced Allium-type of embryo sac development in many members of Podostemaceae. The work of Magnus being subjected to much criticism by Maheshwari, the present writer investigated two members of the Podostemaceae, *Lawia zeylanica* and *Griffithella Hookeriana.*

Usually the megaspore mother cell forms a dyad. The upper dyad degenerates and the lower acts as the embryo sac mother cell. The nucleus of this embryo sac mother cell undergoes three divisions before the embryo sac is organised. Degeneration of the chalazal end may start even during the first division or immediately after it, or during the second division of the primary embryo sac nucleus.

The primary chalazal nucleus may divide once, in which case the mature embryo sac will be 6-nucleate as in *Lawia* (Razi, *in press*); or it may persist without division, in which case the mature embryo sac will be five nucleate, as in *Lawia* (Razi), and *Mourera fluviatilis* (Went); or it may degenerate as happens in a majority of cases (*Lawia, Griffithella, Podostemon ceratophyllum, Podostemon subulatus, Hydrobrium olivaceum, Farmeria metzgerioides, Weddelina squamulosa, Apinagia* etc.) to result in a tetranucleate embryo sac. All these tetranucleate embryo sacs have during their development an ephemeral primary chalazal nucleus, and as such can be said to be ontogenetically pentanucleate. Their ontogeny precludes them joining the tetranucleate category, and they are not typically Allium-type. Therefore all such cases are proposed to be brought under the "Podostemon-form of the Allium-type" of embryo sac development.

In some cases, a primary antipodal cell is got at what is normally the two-nucleate embryo sac stage. This rare feature has also been seen in *Butomopsis lanceolata* and *Hydrocharis emarginata* by Johri.

One more peculiarity is the development of a short lived *upper polar cell* in *Griffithella Hookeriana* (Razi, *in press*). A similar stage has been drawn by Magnus for *Podostemon subulatus.*

The lower end of the embryo sac becomes continuous with the pseudo-embryo sac by the dissolution of the intervening wall in *Lawia* and *Griffithella.* This caecum acts as a haustorial organ during early embryogeny.

17. The Embryo sac of *Chrysanthemum parthenium* L. (Bernh).

P. Maheshwari and Ashraful Haque, Dacca.

The species has already been investigated by two Swedish workers, namely Palm and Fagerlind. As both the accounts differ in some ways, a reinvestigation was thought to be desirable.

The present material was collected by one of us from the Brooklyn Botanic Garden, New York.

The ovule is unitegmic and tenuinucellate. The hypodermal archesporial cell functions directly as the megaspore mother cell and is often mounted on two or three axial cells of the nucleus. The two meiotic division proceed normally and result in the formation of the four megaspore nuclei. No appreciable difference could be noticed in the sizes of the nuclei as reported by Fagerlind, nor are there any nuclear fusions, although in certain cases the two central megaspore nuclei were found in close contact with each other. The eight nuclei of the next stage lie in four pairs, each pair being separated from the next by a vacuole. Preparatory to the last division, the micropylar pair of nuclei becomes further removed from the remaining three pairs by an increase in the volume of the vacuole between the first and the second pair of nuclei. The next stage shows 16 nuclei, 4 at the micropylar and 12 at the chalazal. These organise to form a three celled egg apparatus, two polar nuclei and 11 antipodal cells all of which are usually uninucleate. In contrast with the observations of Palm and Fagerlind, basal antipodal cell never shows more than one nucleus. Nor does it differ appreciably from the other antipodal cells in size. But sometimes one or the other of the remaining antipodal cells may be binucleate. Eventually all of the antipodals degenerate forming a dark streak which is absorbed during later development.

It was noted that as in other Compositeae, the nucellar epidermis disorganises during the development of the embryo sac and the innermost layer of the integument becomes differentiated as the endothelium. A peculiar feature is that most of the cells of the anther-tapetum degenerate *in situ* and only a few protrude inside into the anther loculus. A true periplasmodium was never seen in our material.

18. The Embryology of *Ottelia alismodies* Pers.

AHMAD SHAMSUL ISLAM, Dacca.

Ottelia alismoides flowers abunduntly at Dacca during the months of September and October. The present work was undertaken to check and enlarge upon the findings of S. K. Narasimha Murthy who studied the embryology of this species in 1935.

The pollen grains are spherical with spiny projections all over the exine. At the shedding stage they show a crescent-shaped generative cell and a spherical vegetative nucleus.

The primary archesporial cell does not function directly as megaspore mother cell. In all cases a parietal cell is cut off. After the first meiotic division of the megaspore mother cell the chalazal dyad cell alone divides again resulting in a row of three cells. The functioning megaspore undergoes three divisions to produce a normal eight-nucleate embryo sac.

The pollen tube does not disappear after fertilisation and is traceable even in the ovules with well-developed embryos. Another peculiar and interesting feature is the occurrence of pollen grains inside the ovary as have also been reported in-*Butomopsis lanceolata* and *Erythronium americanum* by Johri and Haque respectively.

The endosperm is of the Helobial type. Contrary to the observations of Narasimha Murthy, the chalazal chamber is much smaller than micropylar and as a rule its nucleus remains undivided.

The development of the embryo is of the Sagittaria type. The basal cell becomes much enlarged and vesicular and can be recognised even in fully mature embryos.

19. The development of the female gametophyte and endosperm in *Moniera Hamiltoniana* T. Cooke.

K. M. SAFIULLA and H. C. GOVINDU, Bangalore.

The ovary in *Moniera Hamiltoniana* T. Cooke. is superior and bilocular with many unitegmic anatropous ovules borne on a massive axile placenta. The hypodermal archesporium directly functions as the megaspore mother cell. Megasporogenesis proceeds normally and the embryo sac is developed according to the normal or *Polygonum* type. Sometimes a T-shaped tetrad is met with. The innermost layer of the integument forms the endothelium or the integumentary tapetum and it functions as a nutritive layer.

In the mature embryo sac the synergids are elongated and show characteristic nooks. The egg is pear shaped and lies in between the synergids. The antipodal cells degenerate early. Starch grains are usually present in the mature embryo sac and sometimes even at the megaspore tetrad stage.

Endosperm development is *ab initio* cellular. Two types are noticed in the early development of the endosperm. It develops haustoria at either ends. The micropylar haustorium, is four celled, each cell uninucleate. It is more aggressive than the chalazal haustorium and persists up to a late stage in the seed. The chalazal haustorium is uninucleate and is very aggressive to begin with but disappears during the later stages of the seed.* Endosperm tissue is situated between the two haustoria and it shows prominent nuclei and plenty of nutritive contents which take up a deep stain. The epidermal layer of the seed coat develop prominent thickenings on its outer wall.

20. A note on the development of the endosperm in *Stylidium graminifolium* Swartz.

K. SUBRAMANYAM, Bangalore.

Stylidium graminifolium Swartz is a member of the family *Stylidiaceae* and materials of this plant, for the present study were available from New South Wales, Australia.

After double fertilisation, the primary endosperm nucleus which is situated in the upper region of the embryo sac divides. This is followed by the laying down of a transverse wall resulting in a primary micropylar and a primary chalazal chamber. A vertical wall is then laid down in the primary micropylar chamber followed by a similar wall in the primary chalazal chamber. The endosperm is now made up of four cells, with two cells in each tier.

Next, transverse walls are formed in each of the tiers of the four-celled endosperm. First, a transverse division occurs in the upper tier of cells and this is soon followed by a similar division in the lower tier; the result is an eight celled endosperm made of four tiers of two cells each as in certain members of the closely allied family Lobeliaceae.

At the eight-celled stage of the endosperm, the two cells of the upper tier develop into the micropylar haustorium and of the lower into the chalazal haustorium. The two middle tiers form the main body of the endosperm. Thus the sequence of wall formation closely corresponds to the Scutellaria type of Schnarf. A similar sequence has been reported by Rosen for *Stylidium adnatum* and is also seen in the different species of *Lobelia,* a genus of the closely allied family Lobeliaceae.

21. The problem of the conservatism of the Vascular Bundles.

A. C. JOSHI, Hoshiarpur and V. S. RAO, Delhi.

While it has been generally believed for a long time that the vascular bundles are conservative and tend to persist after the organ which they previously supplied has disappeared, Arber some years ago strongly challenged this assumption. The study of the floral anatomy of approximately 4 dozen species of Acanthaceae provides interesting evidence bearing on this problem. This family shows progressive reduction in the androecium. Some forms have four functional stamens and a staminode; some, four functional stamens only; some, two functional stamens and two staminodes; and others, only two functional stamens. In *Ruellia tuberosa* Linn., *Barleria prionites* Linn., *B. cristata* Linn., and *B. strigosa Willd.*, which have an androecium of four stamens and a staminode, five staminal traces enter the corolla tube, one of which is small and supplies the staminode. In *Hemigraphis colorata* Hallier f. and *Strobilanthes callosus* Nees, which also possess four functional stamens and a small staminode, there is a staminodal bundle but this runs only in the corolla tube and fades away before reaching the base of the staminode. In *Hygrophila serphyllum* T. Anders, *Asteracantha longifolia* Nees, *Rullia cernua* Roxb., *Barleria lupulina* Lindl., *Blepharis boerhavifolia* Pers, and *Aphelandra pectinata* Wild. ex Nees, the androecium consists of only 4 stamens. There is no staminode. Still, there is a vascular bundle present for the missing staminode. It runs in the corolla tube nearly upto the level of insertion of the stamens. In *Thunbergia fragrans* Roxb., *T. grandiflora* Roxb., and *Crossandra undulaefolia* Salisb., the position is similar except that the trace for the missing staminode runs in the corolla tube much above the level of insertion of the stamens. In *Sanchezia nobilis* Hook. f., a staminode is present, although very greatly reduced, yet there is no vascular supply for it, and the staminodal trace is completely suppressed.

Thus we see that the vascular bundles show considerable variety in their relation to the degenerating organs. Sometimes they disappear before the organ has completely disappeared, while in other cases they presist after the organ which they supplied has ceased to exist. This conclusion agrees with that of Bechtel, based on the study of Urticales, and should be noted when attempt is made to elucidate the morphology of any floral part with the help of anatomical evidence.

22. The Origin and Development of Stipules in *Morus alba* Linn.

G. P. Majumdar and G. C. Mitra, Calcutta.

Cross (1937) has already published an account on this subject, but as his findings are fundamentally different from the accepted position re-investigation of the problem with local material was undertaken.

According to Cross (1) stipular primordia originate by suppression of growth at two points on opposite sides of apex of a primordium (base) when 70 μ high and before the lateral trace bundles differentiate in the latter, (2) lateral trace bundles originate in the base and then differentiate basifugally in the primordium and basipetally to join the axial ring, (3) the stipular traces originate at the base of the stipular primordia and then make their connection with the laterals; they are not branches of the latter. He even suggests that "the stipules are....products of the closely adjacent *cauline tissue* which has diverged slightly at the node in adjustment of leaf production. The diverged portion of the node might then be considered a leaf-stem transition region."

Our studies of the local material of the same species on the other hand support the accepted Leaf-base Divergence Theory of the origin of stipules under the influence of branches from the laterals of a three bundle trace. The non-contiguity of the leaf and stipule scars which "are separated by appreciable nodal areas,' and which prompted Cross to suggest an alternative interpretation of the origin of stipules as noted above has been explained. Other points raised by Cross have also been criticised in the light of the data at the disposal of the authors.

23. Some abnormalities in the inflorescences of *Saccolepis myosuroides* A Camus and *S. interrupta* Stapf.

Reayat Khan, Dacca.

The phenomenon of "vivipary" (used in Mattfeld's (1820) and Engler's (1826) sense to denote cases in which bulbils develop in the inflorescence and sometimes germinate on the parent plant), is well-known in some genera of the Gramineae, *e.g.*, *Deschampsia*, *Festuca*, *Poa* etc. but has apparently not been recorded in *Saccolepis*. The specimens on which this study is based were collected from places in the Chittagong and Dacca districts and are deposited in the Herbarium of the Dacca University.

The normal inflorescence in *S. myosuroides* and *S. interrupta* is a cylindrical spike-like panicle in which the rachis is furrowed and bears small pedicellate spikelets in little fascicles. The viviparous inflorescences are conspicuous by the presence of one or more vegetative shoots projecting from the rachis. They are borne in the position of the spikelets on greatly elongated pedicels and consist of several leafy structures resembling large sized bracts some of which may be ligulate. In some cases an axis bearing a few spikelets was seen to protrude out from amongst the leafy structures.

In some specimens of *S. myosuroides* the abnormal inflorescences become divisible into two or three distinct parts separated by naked areas of considerable length. Each part consists of an involucre of several conspicuous bracts and from amonst these arise shoots of both kinds, vegetative as well as reproductive, the latter bearing only a small number of spikelets.

Since only Herbarium specimens were available it is not possible at the present moment to determine whether these abnormal shoots can act as propagules or bulbils but their appearance strongly suggests that this is not very unlikely. The work is being continued further.

24. The Embryo sac of *Erythronium americanum.*

ASHRAFUL HAQUE, Dacca.

The genus *Erythronium* belongs to the family Liliaceae, sub-family Lilioideae and tribe Tulipeae. In all it comprises 19 species of which 17 occur in North America, one in Japan and one in Eurasia.

Material of *E. americanum* was obtained through the courtesy of Dr. H. W. Bannan of the University of Toronto.

The ovary is trilocular, each loculus containing two rows of anatropous, bitegmic ovules.

One of the hypodermal cells of the nucellus becomes differentiated as a primary archesporial cell, which soon increases in size and becomes two to three times as long as broad. This functions directly as the megaspore mother cell. Only three divisions intervene between this stage and the mature embryo sac, and the development is, therefore, of the Adoxa type. The phragmoplasts between the dividing nuclei often persist for a long time and occasionally the spindles of the second division were found to persist along with those of the first division.

In some four-nucleate embryo-sacs the nuclei showed a 1+3 arrangement instead of the usual 2+2. In others, the two chalazal nuclei were much larger than the two micropylar ones. Several eight-nucleate sacs were also met with in which the four micropylar nuclei were much smaller than the four chalazal ones. These three features suggest that, occasionally, the development is of the Fritillaria type. Further a few sacs were observed in which the micropylar end had the usual four nuclei whereas the chalazal end showed only two nuclei which were however of a much larger size. This can be interpreted as a reduced form of the Fritillaria type in which the last division failed to occur at the chalazal end of the embryo-sac.

The pollen grains show a spherical or a crescent-shaped generative cell and an irregularly shaped vegetative nucleus. An interesting feature is the frequent occurrence of pollen grains inside the ovary, one slide alone showing about one hundred and thirtyfive pollen grains in this position.

The chromosome number is $n = 24$ and $2n = 48$. This is based on counts made from the dividing megaspore mother cells and the last division of the nuclei in the embryo sac.

25. Contributions to the embryology of the Liliaceae I. *Gloriosa superba.*

A. M. EUNUS, Dacca.

The material for study was collected from the Botanical Garden of the Dacca University and from the Government Nursery, Dacca.

The flowers showed two or three sterile stamens partially or completely enclosed inside the ovary, the remaining stamens being quite normal.

The anther is tetralocular. During early stages the distinction between sporogenous cells and parietal cells is not sharp. In later stages the microspore mother cells are surrounded by a tapetum, four to six middle layer show well-developed fibrous thickenings. The tapetal cells remain uninucleate. The divisions of microspore mother cells are successive and the tetrads are usually of isobilateral type although sometimes they may be tetrahedral. The pollen grains are two-celled at the time of shedding.

The ovule is anatropous and bitegmic, both the integuments taking part in the formation of the micropyle. In early stages the nucellus is long and slender. There is a single hypodermal archesporial cell which directly functions as the megaspore mother cell and undergoes the usual meiotic divisions to form a linear tetrad of megaspores. Generally the lowest or chalazal megaspore functions but frequently it is the third and rarely the uppermost. Occasionally two megaspores begin to grow concurrently. The embryo sac is of the usual eight-nucleate type. The antipodal cells become binucleate.

The endospern is of the Nuclear type.

26. Contributions to the embryology of the Liliaceae II. *Albuca Trans valensis* Moss-Verdoorn.

A. M. Eunus, Dacca.

Material of this plant was obtained from South Africa through the courtesy of Dr. S. Krupko of the University of Johannesburg. Only stages in megasporogensis and development of embryo sac and endosperm were available.

The ovule is anatropous and bitegmic. The inner integument forms the micropyle and in later stages its swollen tips form a sort of lid or operculum lying just above the embryo sac. A cross section of the ovary shows conspicuous septal glands. At the base of the funiculus there is a mound of swollen and glandular cells which seem to function as an obturator. Usually the nucellus shows a single hypodermal archesporial cell but in some cases two or three archesporial cell have been seen. The archesporial cell divides to produce a megaspore mother cell and a wall cell. Two wall layers are found over the embryo sac but they degenerate and disappear when the embryo sac reaches maturity. The micropylar cells of the nucellar epidermis become markedly elongated and until the time of fertilization, their nuclei are situated towards upper tangential walls but later they move near the lower tangential walls. Both T-shaped and linear tetrads are formed. The chalazal megaspore functions and gives rise to normally organised eight-nucleate embryo sac. The synergids are peculiar in that the nucleus lies towards the lower end or the cell and a vacuole occupies the upper end, which is the reverse of the usual condition. One of the synergids always persists until some time after fertilization.

The endosperm is of the Helobial type and the chalazal chamber shows about half a dozen nuclei.

27. The embryology of *Juncus prismatocarpus* Br. and *J. effusus Linn.*

B. Zaman, Dacca.

Material of these two species of *Juncus* was obtained from Shillong. The ovary is tricarpellary and unilocular, and bears 3 parietal placentae. It contains an indefinite number of anatropus ovules arranged in two rows on each placenta. The inner surface of the perianth lobes is heavily lignified; stomata are borne on the outer surface only. The style is hollow with a triradiate lacuna.

The microspore mother cells are surrounded by the uninucleate cells of tapetum, two layers of parietal cells, the endothecium, and the epidermis. The pollen grains are united in tetrads. The generative cell is cut off towards the inner end of each cell of the tetrad, but it soon moves from its original position and lies free in the vegetative cytoplasm where it divides to form the two male gemetes.

The ovules are bitegmic. Each of the integuments is two-layered. A hypodermal cell of the nucellus becomes differentiated as the primary archesporial cell which divides to form a parietal cell and the megaspore mother cell. This undergos the usual meiotic divisions to form an axial row of four megaspores of which the innermost functions and the other three degenerate. The development of the embryo sac is of the Polygonum type.

The endosperm is of the Helobial type. The nucleus of the chalazal chamber divides only once but several free nuclear divisions take place in the upper chamber followed by wall formation. In the mature seed the endosperm cells seemed to lack any functional nucleus.

28. A revision of the Indo-Malayan Species of *Chonemorpha* G. Don.

R. SESHAGIRI RAO, Cocanada.*

The confusion in the synonymy of some of the species of the genus, the doubtful points raised in Dr. Chatterjee's paper on "the genus *Chonemorpha* G. Don" published in *Kew Bullentin*, No. 1. (1947) and the recent addition of a new species, have necessitated further clarification and revision of the genus.

The genus is mainly confined to tropical and sub-tropical zones of India, Burma, Malaya, Peninsula, Malayan Archipelago, Siam, Annam and China. There are 14 species recorded so far, of which India claims 4 species and the Malayan region, 2 species.

Chonemorpha fragrans (Moon) Alston based on the earlier name *Echites fragrans* Moon (1824) is the valid name and not *Chonemorpha macrophylla* (Roxb.) G. Don which is based on *Echites macrophylla* Roxb. (1832), a nomen nudum. As per homonym rule, *Chonemorpha blancoi* Merr. but not *Chonemorpha elliptica* (Blanco) Merrill et Rolfe, is the valid name. *Chonemorpha pedicellata* Seshagirirao Sp. Nov. is typically distinct by the presence of long pedicels, peduncle and long finely pubescent calyx with conical lobes.

A synoptical key to the species, illustrated specific descriptions with additional notes on distribution, discussions on points of validity, synonymy, references to literature and citations of herbarium specmens are given in the paper.

29. Occurrence of *Paragrewia* Gagnep. in India and Burma.

R. SESHAGIRI RAO, Cocanada.

In 1945, Gagnepain published a new genus, *Paragrewia*, the type of which is *Paragrewia poilanei* Gagnep. collected from Annam. During the study of the Indo-Burmese Species of *Grewia*, a few doubtful specimens of the Calcutta and Madras Herbaria collected from Salween (Burma) and Tinnevelly, (S. India) have been examined and identified as *Paragrewia poilanei* Gagnep.

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* This work was done at the Herbarium, Royal Botanic Garden, Sibpur.

Paragrewia resemble *Grewia* in habit, general form of leaf and structure of ovary but differs from *Grewia* by the absence of androgynophore and also of glandular depression at the inner base of petals and by the presence of limited number of stamens, namely, 15.

The distribution of *Paragrewia* is peculearly discontinuous. The genus has not so far been recorded anywhere between Annam and Burma and between Burma and southern-most part of the Peninsular India.

A detailed illustrated description of the species, citations of herbarium specimens and a brief discussion on the distribution of the species are given in the paper.

30. *Primitivity of the Angiosperms (With special reference to the presence of pollen grains in the stylar canal and ovary of members of the family Butomaceae).*

B. M. Johri, Delhi.

The two great groups of plants, the Gymnosperms and the Angiosperms, have long been separated on such old ideas as (*a*) presence or absence of vessels in vegetative parts, (*b*) floral structures, (*c*) pollination and fertilisation and (*d*) gametophytes and embryogeny. The discovery of *Caytonia,* which was formerly supposed to be the first fossil angiospermic type of carpel has definitely been claimed to be gymnospermous on the basis of the further discovery of pollen grains in the micropyles of *C. thomasi, C. sewardi* and *C. nathorsti.*

Thompson's work on *Gnetum* has clearly shown the presence of vessels in its wood which are more or less of the same type as found in angiosperms. The floral structures of some of the apetalae bear close resemblance to flowers of *Ephedra.* The presence of pollen grains in the stylar canal and in the ovary of *Butomopsis* and particularly the germination of the pollen grain on the ovule brings it very close to *Caytonia.* The micro-and megasporogenesis as well as the gametophytes of *Ephedra* and *Gnetum* are closely allied to those of angiosperms.

The concept of foliar origin of angiospermic carpel has received considerable attention during recent years. The carpels with partly open margins and hollow stylar canals as in *Alismaceae* and *Butomaceae* must be regarded as much more primitive than closed carpels with stylar canals completely filled with nutritive tissue. The hollow stylar canal was evidently replaced by nutritive tissue as the stigma became closed.

In 1935 the author made a chance discovery of finding pollen grains in the stylar canal and in the ovary of *Butomopsis lanceolata.* In one case a pollen grain had actually produced a short pollen tube on the surface of the ovule. This work has further been followed up and now pollen grains have been observed in the canals and often in the ovaries of the remaining three members of the family *Butomaceae—Butomus umbellatus, Limnocharis emarginata* and *Hydrocleis nymphoides.* Such a case has not been reported as a normal feature in any other Angiosperms except in some stray cases like *Moringa* where Puri has reported one case of seeing pollen grains in the stylar canal. Such stray cases must be left out of consideration as compared to the normal presence of pollen grains in *Butomaceae.*

Great significance must be attached to this discovery because it does confirm, even if only to a certain extent, the primitivity of the Butomaceae among the Angiosperms and it does lend a great support to the former view of regarding *Caytonia* as an angiospermic form.

Whether the angiosperms are monophyletic or polyphyletic in origin is also a related question which deserves some consideration in this connection. A sum total of all the taxonomical, anatomical, embryological and genetical evidence would support the view that angiosperms are definitely polyphyletic in origin. Just as *Butomaceae* are primitive among the monocots, the *Ranunculaceae* which is closely allied to the *Alismaceae* and *Butomaceae* are primitive among the dictots. Whether monocots are primitive to dicots or vice versa has been a very baffling problem. Conflicting opposite views have been expressed by Engler and Bentham & Hooker. The discovery of *Ranalisma* by Ridley, a plant closely allied to *Ranunculus* and *Alisma* is most interesting but unfortunately not more than one (or two) specimen of this rare plant has been found to undertake its detailed study which might have produced some evidence to decide the primitivity of the monocots and the dicots. However, it is likely that the *Ranunculaceae* and the *Alismaceae* might have had their origin from a common ancestry represented by forms like *Ranalisma.*

The fossil remains of any angiospermic flower have been most scarce. The only single well preserved specimen of *Sahnianthus* from the Tertiary period of India has been placed in the family *Lythraceae* as has been studied and recorded by its discoverer Dr. Shukla. Although the position of the flower under the Lytthraceae seems somewhat doubtful, it is at once clear that dicots were flourishing during the Tertiary period. The evidence on this score could not be conclusive until after some time when more forms have been discovered.

The problems of primitivity of angiosperms is a fundamental one and interesting in more than one way. Its serious consideration raises more than one baffling problems. The author's present discovery of pollen grains in the stylar canal and ovary of *Butomaceae* place them very near to the gymnosperms and *Caytonia* which has been acclaimed as a gymnosperm can definitely be regarded as a connecting link between the gymnosperms and the primitive angiosperms if it can not be considered as an undisputed angiosperm. We must therefore give a new orientation to our ideas of the distinctions between gymnosperms and angiosperms on which their separation is based.

Cytology and Genetics

31. What determines inequality in size of the male nuclei in the genus *Ephedra?*.

P. N. Mehra, Amritsar.

The formation of the male nuclei by the division of the body cell nucleus has been studied in 6 species of the genus *Ephedra.*

In *E. foliata* and *E. sinia* the two male nuclei are of the same size, in *E. likiagensis* the male nuclei may be equal or unequal but in the latter case there is no marked difference while in *E. altissima, E. intermedia* and *E. saxatilis* they are markedly unequal particularly in the last species.

The inequality where present is due to the hetero-polar nature of spindle of the dividing body nucleus. The spindle half towards the stalk nucleus end is late in appearance, truncate and blunt in contrast to the spindle half on the other side which is converging. The chromosomes when they reach the pole at the blunt end are consequently dispersed and scattered compared to those on the opposite side where they form a compact mass at telophase. The nucleus formed towards the stalk nucleus end, therefore, is invariably bigger than its sister on the other end. There is thus no difference in the amount of chromatin in the two nuclei but there is obviously some in the amount of karyolymph. The two nuclei if unequal, maintain this difference even during their further growth in the pollen tube.

Species which possess unequal male nuclei in the normal haploid pollen grains, exhibit the same difference even in diploid grains if formed.

32. Sex Chromosomes of *Trichosanthes palmata*, Roxb.

K. RANGASWAMI, Annamalainagar.

The present work on the cytology of *Trichosanthes plamata,* Roxb. has been undertaken with a view to finding out if the dioecious habits of this plant is due to the presence of sex chromosomes.

T. palmata is a sturdy tendril climber with palmately lobed leaves, the upper surface of which is scabrid and is studded here and there with green dots. This is a dioecious plant growing commonly in and around this locality.

In the course of the present investigation, the meiotic and mitotic chromosome numbers of this plant have been determined for the first time. There are 22 and 44 respectively. The haploid chromosome number was determined by tracing the microsporogenesis in the male plant, while the somatic chromosome number was counted in the root tip cells of both the male and the female climbers.

Previous work on another dioecious species of this genus, namely, *T. dioica,* Roxb, has not revealed the existence of sex chromosomes in meiosis as well as in mitosis. But in this plant a heteromorphic chromosome pair has been observed at the metaphase and anaphase stages during meiosis. Difference has been noted between the somatic chromosomes of the male and the female plants. The sex chromosomes are of the XX (female) nad XY (male) type. The X chromosome is the largest and the Y the smallest. Thus the prevalence of dioecious habit in this plant is to be attributed to a difference in the nature of their chromosomes.

33. Cytological Study of the Indian Aristolochiaceae—I.

S. VENUGOPALAN, Annamalainagar.

Root-tips of *Aristolochia indica, A. bracteata* and *A. elegans* were studied; and the somatic chromosome numbers (2n) have been determined as under, for the first time: I. *Aristolochia indica*—12; 2. *A. bracteata*—12; 3. *A. elegans*—14.

Besides, the microsporogenesis of *A. indica* and *A. bracteata* have also been worked out and the meiotic chromosome numbers have been found as 6. This confirms the count of the somatic chromosome numbers.

Megaspore development has been traced and it is of the normal monosporic type.

Organogeny of floral parts seems to indicate that the flowers of *A. indica* and *A. bracteata* are protandrous contrary to the accepted belief that they are protogynous.

The work on *A. elegans* is continuing.

34. Cytological Studies in Combretaceae I.

V. R. RAJAGOPALAN, Annamalainagar.

Work on the cytology of *Combretaceae* was started just a year ago. The following genera are available for investigation in this locality: *Quisqualis, Terminalia, Calycopteris, Combretum* and *Lumnitzera.* The somatic chromosome number of the first mentioned plant namely, *Quisqualis indica,* Linn., has been determined for the first time from the root tip cells. This is found to be 22. Microsporogenesis is being traced to determine the meiotic chromosome numbers also. Work on the determination of the haploid and diploid chromosome numbers of the other genera is also in progress, with a view to finding out any correlation that may exist between cytology and taxonomy of this family.

Difficulty was experienced in the matter of fixation of the root tips and the flower buds because of the presence of a considerable amount of tannin in their cells. This, however, has been overcome to some extent by using a slightly modified Lewitsky's formula (1 part 10% formalin and 2 parts 1% chromic acid).

The present work is only the first of a series of papers on the cytology of *Combretaceae.*

35. Cytology of Apospory in *Doodia aspera.*

P. C. SARBADHIKARI, Calcutta.

The paper deals with the aposporous development of the prothallia which usually occurs on the margin of the leaf. It is at first discernible as a small outgrowth caused by the division both of the marginal cells of the leaf and of those cells lying immediately within the margin. The marginal and apical prothallia are much more regularly heart-shaped, and in fact resemble ordinary prothallia of delicate structure. As the growth proceeds it is distinguished as a more or less continuous sheet of delicate tissue formed of somewhat rectangular cells.

The study of many pinnules show the apex either produced into a single prothallus or crowned by a number of prothalli with isolated groups. The principal cytological interest in the prothalli centres in the number of the chromosomes and in a comparison between the prothallus and the sporophyte in this respect. The embryo arises as a direct vegetative outgrowth from the prothallus, and, when very young, consists of a mass of cells in which the apical cells of the cotyledon, stem and root, are recognisable. There is no reduction of the chromosomes on passing from the sporophyte to the gametophyte.

36. Further investigation on the cytogenetics of *Scilla* species.

P. N. BHADURI and A. K. SARMA, Calcutta.

A comparative study of the idiograms in the following six different species of *Scilla* has been made:—*S. verna; S. amethystina; S. autumnalis; S. bifolia; S. sp.* (unidentified) and *S. pratensis.* Besides other cytological data a careful measurement of the individual chromosomes, as well as the total length of chromosomes in the complement has been made to find out the lines of evolution in the genus. There are at least two distinct aneuploid series, one starting with *S. sibirica,* $n=6$ and the other from a still unknown species, but containing in the series the unidentified species of the present investigation ($n=7$) and *S. bifolia* ($n=9$).

An exact correlation between the maximum number of nucleoli and the total number of secondary constrictions of chromosomes has been established. It has been confirmed that the relative size difference between nucleoli is a constant and specific character. Species having heteromorphic pairs of nucleoli as found in the unidentified species of *Scilla* produce dissimilar gametes with respect to nucleoli and satellited chromosomes and hence should be considered as structural hybrids.

Definite evidence has been put forward in case of S. *amethystina* to show that the karyotype is altered in the same tissue due to fragmentation and translocation of chromosomes. The implication of such alteration of karyotypes in the production of new forms has been pointed out.

A study of the heterochromatic bodies present in the resting cells and the nucleolar constrictions of the metaphase chromosomes indicates that there are two kinds of heterochromatin which differ from each other in structure and function.

37. Karyotype analysis in some of the Indian strains of Barley.

P. N. Bhaduri and A. K. Sarma, Calcutta.

A critical re-investigation of the morphology of the chromosomes has been made in six strains of Indian Barley obtained from the Indian Agricultural Research Institute. Details which were missed by previous workers have been successfully brought out by using special fixatives like Platinic Chloride Formalin mixture and pre-treatments with various concentrations of Colchicine before fixation. Barley chromosomes are fairly long mostly with a median primary constriction. In three strains, 3 pairs of chromosomes have 10 secondary constrictions between them. One pair having a typical satellite another with a satellite at one end and an intercalary secondary constriction near the primary one and in the third pair each chromosome has three constrictions distributed in 4 pairs. In the other two strains 14 and 16 only secondary constrictions respectively are found. In the other strain pair of chromosome with intercalary constrictions being absent 8 constrictions are distributed in two pairs. All constrictions are nucleolar and it is suggested that the higher number of nucleoli and secondary constrictions in the cultivated varieties of Barley has been evolved through structural changes of chromosomes involving non-homologous translocation. This can be established by cytological examination of intervarietal crosses. Meiosis in all the strains examined is normal, showing 7 bivalents in the pollen mother cells though occasionally inversion bridges have been observed.

38. Cytogenetics of some common fruit trees I. *Eugenia* species.

P. N. Bhaduri and Ahmed Samsul Islam, Calcutta.

Cytological investigation of the following species of *Eugenia* has revealed that except *E. uniflora* they are all polyploid species: *E. uniflora* $n=11$, $2n=22$; *E. jambos* $n=23$, $2n=;45$; *E. jambolana* $n=33$, $2n=66$; *E. jambolana* var, *caryophylifolia* $n=22$. The confusion in the determination of the chromosome numbers by previous workers has been explained to be due to the presence of multivalents and univalents along with bivalents during the metaphase I of the P.M.C. Due to non-disjunction and lagging of univalents the haploid number during second division was mostly found to be lower than the true haploid number. Hexa-, quadri-, bi-, and univalents are present in *E. jambolana* which is an allo-hexaploid species. Pentavalents in addition to other univalents in *E. javanica* confirms its pentasomic nature $(4+1)$. The basic number in the genus appears to be 11 which is found in *E. uniflora* and also in other genera of the Family. On this basis *E. jambolana* var. *caryophylifolia* is a tetraploid species from which by the union of an unreduced egg with a normal sperm the common *E. jambolana* has arisen. *E. jambos* $(4n+2=46)$ is a hypertetraploid species with a pair of chromosome duplicated.

There is a correlation between pollen abortiveness and different sizes of pollen grains on the one hand and the irregular disjunction of the multivalents on the other.

Cytological evidence shows that *E. jambolana* var. *caryophylifolia* is a tetraploid species quite distinct from the allohexaploid *E. jambolana*. Whether the former is equivalent to *E. cumini* has to be ascertained by further cytological and taxonomical observations.

39. Cytogenetics of some fruit trees II. *Grewia asiatica* Linn. and *Nephalium longana* Camb.

P. N. Bhaduri and Sunanda Bose, Calcutta.

Cytological observations of *Grewia asiatica* Linn. (=*Grewia subenequalis*) and *Nephalium longana* Camb. have shown that the former has $n=18$, $2n=36$ and the latter $n=15$, $2n=30$ chromosomes. *N. longana* is a balanced diploid species showing normal meiotic behaviour and high percentage of fertility. *G. asiatica*, on the other hand, is an amphidiploid species with the tetraploid chromosome number. Due to further structural changes of some of the chromosomes, most probably due to hybridization, the present *G. asiatica* (=*G. subenequalis*) has become a structural hybrid producing at least two quadrivalents and dissimilar gametes during meiosis. In view of the structural hybridity of the species it is expected that closely related but different forms of *Grewia asiatica* should be present in nature. This supports the observation made by Taxonomists that *G. asiatica* Linn. forms a heterogeneous assemblage. The frequency of quarid-, tri-, bi- and univalents during meiosis has been presented in a tabular form. The implication consequent to disjunctional or non-disjunctional orientation of ring quadrivalents during metaphase I in their relation to duplication or deficiency of genes in the gametes have been discussed.

A correlation between the multivalent and univalent formation to percentages of abortive and different sizes of pollen grains has been worked out. The present observation supports the view that in a polyploid species duplication or deficiency of one or more chromosomes though affect the size of the pollen grains, may not on the other hand affect the viability which is dependent not on number alone but on the chromosome balance.

40. Preliminary investigation on the cytogenetics of *Trewia nudiflora* Linn., *Chrozophora plicata* Neck., *Flacourtia Ramontchi*. L'Herit., & *F. sepia Roxb.*

P. N. Bhaduri and A. K. Kar, Calcutta.

The chromosome numbers in the following species have been determined for the first time: *Trewia nudiflora* Linn. (Fam. Euphorbiaceae) n=11, *Chrozophora plicata* Neck. (Fam. Euphorbiaceae) n=11, *Flacourtia Ramontchi* L'Herit. (Fam. Flacourtiaceae) 2n=22 and *F. sepiaria* Roxb. n=11.

In the somatic complement of *Flacourtia Ramontchi* there are six chromosomes with secondary constrictions, two of which are extra long in size. A very small satellited chromosome without a homologue has been observed. Definite evidence of the presence of sex-chromosome in any of the species has not been found. The meiotic behaviour of the chromosomes in all the species is normal except in *Trewia nudiflora*, where a high percentage of inversion bridges has been observed. Clear evidence of secondary association between bivalents during first metaphase indicates that the species are probably secondarily balanced polyploids.

An embryological study of *Flacourtia sepiaria* shows a Normal-Type of development of the female gametophyte with a typical octo-nucleate embryo-sac. Exceptional cases showing the development of more than one megaspore has been recorded. The embryological characters of *Flacourtia sepiaria* are in conformity with the characters of the Order Parietales.

41. A preliminary investigation on the karyotype analysis of wild and cultivated Tuberiferous Solanums.

Jyotirmay Mitra, Calcutta.

Although much cytological work has been done in wild and cultivated potatoes, it is still not yet proved whether *Solanum tuberosum* is an auto or allo-tetraploid species. Gates has pointed out that a new line of evidence in this direction could be obtained from the study of karyotypes and nucleolar relations. Critical karyotpe analysis in a few diploid and tetraploid species has only been done by Sepeleva using Platinic Chloride as a fixative. Other workers in this direction are not so critical

Material of wild and cultivated potatoes fixed in Platinic chloride mixture which was collected at Cambridge during 1938 has been analysed. Analysis of the somatic chromosomes of two diploid (wild), two triploid (wild) and four tetraploid (both wild and cultivated) species and varieties has been made. In the two diploid species *viz., S. pseudomaglia* and *S. Kesselbrenneri* preliminary observations have shown that there are 8 and 10 to 12 secondary constricted chromosomes in the two species respectively; and in the two triploid species *viz., S. Rybinii* and *S. Commersonii* there are 18 secondary constricted chromosomes. In a tetraploid variety (Sharpes Express) as many as 26 secondary constricted chromosomes could be detected. In "King Edward" there are two and in "Champion" four fragments are present in the chromosome complement. For the first time a triploid form of *S. Rybinii* has been found. The nature of polyploidy and the probable cytological basis of origin of different cultivated varieties have been discussed.

42. *Cytogenetical studies in Musaceae. I. Karyotype analysis of *Musa* and fragmentation of chromosomes as an evolutionary process in the genus.

A. K. Chakravorti, Calcutta.

The subgenera of *Musa* have different chromosome numbers; *Physocaulis* having $2n=18$, *Eumusa* $2n=22$ (wild and diploids) or $3n=33$ (cultivated and parthenocarpic triploids) and *Rhodochlamys* has $2n=20$ (*M. coccinea, M. borneensis* etc., determined by Cheesman & Larter) or $2n=22$ (*M. rubra, M. ornata* etc.).

Karyotype analysis of different species shows 17 morphologically distinguishable types of chromosomes. Individual species have distinctive karyotypes composed of 2 to 6 of the above 17 types of chromosomes.

The maximum number of nucleoli in *Physocaulis* and *Eumusa* are exceptionally high (26 to 34) corresponding to similarly high number of nucleolar constrictions of the chromosomes. Neither polyploidy nor previous non-homologous interchange between nucleolar and non-nucleolar chromosomes, nor fragmentation of chromosomes across their secondary constrictions can explain the high number of nucleoli observed. It has therefore been deduced that a genome may possess more than one and even many nucleoli instead of only one as originally visualised by De Mol.

Evidence has been put forward to show that the diploid species of *Eumusa* having $2n=22$ chromosomes have originated from the 18-chromosomed species like *M. superba*, through fragmentation of its two particular pairs of chromosomes across the secondary constriction regions.

43. *Cytogenetical studies in Musaceae. II. Meiosis in some diploid species of *Musa* with special reference to secondary association of bivalents.

A. K. Chakravorti, Calcutta.

Meiosis studied in 8 different diploid species of the subgenera *Physocaulis* and *Eumusa* is normal and regular excepting *Ram kela* (a native name of the species which grows wild in the Chittagong Hill Tracts, E. Pakistan, and appears to be a new one) belonging to *Eumusa*. On the grounds of meiotic irregularities, this species has been interpreted to be a structural hybrid produced in consequence of segmental interchange between non-homologous chromosomes.

A correlation between the size and sterility of the pollen grains to meiotic irregu-

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*These investigations were carried out with the aid of a grant from the Indian Council of Agricultural Research.

While the most frequent association between bivalents varies from species to species, the maximum association on the other hand, is the same in all the species of a subgenus. Thus the two species of *Physocaulis, M. superba* and *M. Agharkarii* have both 1 (3)+3 (2) bivalents as their maximum association, while all the 6 species of *Eumusa* examined show a maximum association of 1(4) +1(3) +2(2) bivalents. The nature of maximum association indicates that 4 should be the basic chromosome number for the genus and not 8 as previously suggested by Cheesman.

The morphology of the chromosomes and the type of maximum association of bivalents in the two species of *Physocaulis,* indicate that they are amphidiploids originated from a basic set of 4 chromosomes.

44. * Cytogenetical studies in Musaceae. III. Cytological considerations for the delimitation of the subgenus *Rhodochlamys* of the genus *Musa.*

A. K. CHAKRAVORTI, Calcutta.

Cytological studies have been made in 5 species of *Rhodochlamys.* This subgenus constitutes a cytological group quite distinct from *Eumusa.* The two subgenera cannot however, be distinguished from each other on morphological characters alone, except that *Rhodochlamys* has fewer flowers (1 to 6) in one row per bract as compared to many in two rows in *Eumusa.* Nor are they separable on the basis of seed-shape and chromosome-number as claimed by Cheesman and Larter.

It has been found that only in the details of the morphology of the chromosomes, the size relation and maximum number of nucleoli, and the nature of the maximum association between bivalents, the two subgenera are distinguishable from one another. Thus *Rhodochlamys* has fewer morphological types of chromosomes, which are again, quite distinct and appear to be phylogenetically different from those found in *Eumusa.* The members of *Rhodochlamys* have much smaller number of nucleoli (10-14) of distinct and fewer size classes in contrast to those of *Eumusa,* which have unusally high number of nucleoli (26-34) of various sizes. Again the nucleolar constrictions of *Rhodochlamys* are all of the nature of satellites, whereas in *Eumusa* they may be satellites, secondary constrictions and SAT-threads alone without the SAT-heads. Further, the supernumerary constrictions, the presence of which is a remarkable feature in some of the chromosomes of *Eumusa,* are exclusively lacking in *Rhodochlamys.* Lastly, the maximum association between bivalents in *Rhodochlamys* is 3 (3) + 1 (2) as against 1 (4) + 1 (3) + 2 (2) of *Eumusa.*

The cytological facts put forth above do not indicate any close relationship of *Rhodochlamys* to either *Physocaulis* or *Eumusa.*

45. *Cytogenetical studies in Musaceae. IV. Karyotype analysis of the parthenocarpic bananas and the cytological basis of their variation.

A. K. CHAKRAVORTI, Calcutta.

The parthenocarpic bananas are all allotriploids with $3n=33$ chromosomes. A remarkable feature of the karyotypes of the different varieties is that they are variable within a given variety and even within the same individual. Such variations are noticeable with respect to the number of chromosome types, number of a particular type of chromosome, sum total of lengths of all the members of a chromosome complement, length of an individual member, total number of nucleolar constrictions etc.

Such occasional and spontaneous changes in the morphology of the chromosomes have been explained on the basis. of rearrangement of chromosome segments following translocation, deletion and inversion in the somatic nuclei.

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* These investigations were carried out with the aid of a grant from the I.C.A.R.

Like the variability of the karyotypes, the degree of pairing between the chromosomes is also variable in different varieties.

The origin of numerous parthenocarpic varieties of banana under cultivation which have no scope of producing new types by hybridization and which are accustomed to clonal propagation alone, is due to the above process of chromosome rearrangements operating in the somatic meristem. A vegetative bud developed from such a mutated tissue will represent a well-defined genotype which is also likely to differ phenotypically from the parent.

46. *Cytogenetical studies in Musaceae. V. Idiogram studies with special reference to Chromosome-Nucleolus relationship and its bearing on the cytogenetics of *Heliconia*.

A. K. CHAKRAVORTI, Calcutta.

The genus *Heliconia* has two lines of chromosome number, 2n=22 and 2n=24. The 24-chromosomed species, like *H. brasiliensis*, have evolved from the 22-chromosomed ones, like *H. metallica*, by fragmentation of a particular pair of chromosomes across the secondary constrictions.

The different species have a fairly large number of nucleoli and correspondingly a specific character. *H. psittacorum* and an undetermined species are structural produced after fragmentation of a chromosome across the secondary constriction are capable of organising a nucleolus due to the presence of a piece of constriction-thread at one end. It is suggested that fragmentation across nucleolar constriction may not only alter the karyotype but may also bring about a proportionate increase in the maximum number of nucleoli depending on the locus of the break.

The relative size difference between nucleoli of a species has been found to be a spcecific character. *H. psittacorum* and an undetermined species are structural hybrids with reference to heteromorphism in the nucleolar size. This is correlated to heteromorphism in a pair of nucleolar chromosomes and the formation of a quadrivalent ring in the P.M.Cs.

A study of the idiograms of the different species suggests that structural changes of chromosomes and not polyploidy have played an important role in the differentiation of the species of *Heliconia*.

Cytological findings support the separation of the genus *Heliconia* as a distinct tribe *Heliconieae* from the *Strelitzieae*.

47. On the cytogenetics of cultivated Jasmines.

SM. MRIDULA DUTT, Calcutta.

Mitotic and Meiotic studies of six ornamental speceies of *Jasminum* are being carried out.

The diploid number 2n=26 occurs in four species while one shows the triploid number (3n=39) and another the tetraploid (4n=52). Meiotic irregularities include formation of multivalents in the polyploid forms with trivalent and quadrivalent chains predominating, and with a corresponding percentage of univalents. Secondary association is seen in one species, which also casts out several (3-5) small chromatic bodies in the cytoplasm during meiotic anaphase.

There is an abundance of aborted pollen which is correlated to the meagre formation of fruits and complete sterility of seeds. Germ pores vary in number from one to four, the greatest incidence of the highest number being found in the tetraploid.

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*This investigation was carried out with the aid of a grant from the I.C.A.R.

PHYSIOLOGY AND ECOLOGY

48. The Structural Basis of Sensitivity in *Mimosa Pudica* Linn.

SM. MRIDULA DUTT, Calcutta.

Reaction to stimuli consists in the bending up and down of all pulvini of the bipinnate leaf. This is facilitated firstly by the centralization of the xylem vessels which are only spirally thickened, and secondly in the cortex being aerenchymatous. Air spaces render it possible for the spongy tissue with isodiametric elements to undergo compression or expansion with ease. Absence of stomata on motor parts and the presence of compact tissue on either side of the spongy pulvinus help in its contractility. Response results from the differential elasticity of adaxial and abaxial halves of the cortex, one of which is thicker walled than the other. The difference in speed of conduction in stem and leaf may be correlated to only one structural difference, namely the presence of two longitudinal air passages along the petiole, which may help in the conduction of stimuli to interior tissues.

Contractile cells contain specialized deeply staining cell contents, which occur to a lesser extent in other parts. Phloem occurs in 2 strands inside and outside the xylem, and occupies the centre of pulvini, where pith is absent. Specialized hairs occur everywhere and the only outgrowths occurring on motor organs, in contrast to the prickles and hairs on other parts.

49. Growth response of Jute plants to Yeast extract and Vitamin Bi.

J. C. SEN GUPTA, Calcutta.

Two species of Jute-*C. capsularis* and *C. olitorius* were grown in (*a*) Sand culture with mineral solution, and in (*b*) Soil, and the different treatments were the addition to each pot of (i) 0.5 mg. Yeast extract, (ii) 0.05 mg. Vitamin Bi. There were 5 pots, each with 4 plants *i.e.*, 20 plants per treatment. As the plants grew, the course of growth was followed by fortnightly readings of total height, number of internodes, number of mature leaves, and number of leaves shed. In addition the data of initiation of the first flower bud, and the first visible fruit were also noted separately for each plant and the data recorded as mean of 20 plants in each case.

The nature of response though not very well marked may be briefly stated as follows:—In (1) *C. capsularis*—the addition of Yeast extract and Vitamin Bi showed an acceleration of growth in Sand culture, but a retardation in plants grown in Soil; (2) *C. olitorius*—the addition of Yeast extract and Vitamin Bi produced a retardation of growth in Sand culture, but an acceleration in Soil.

The time of flowering and fruiting seemed to remain uninfluenced in the different treatments.

50. Preliminary Investigations on Growth of *Cephaelis ipecacuanha* under tropical conditions of Calcutta.

G. C. MITRA and D. CHAKRAVARTY, Calcutta.

The experiments were carried out on prepared soil beds and under thatched shade as is being done in the nurseries of Mungpoo. The seeds of *Cephaelis ipecacuanha* (Kew variety) sprouted in April after 4 and 5 months of their sowings but they died soon, and the young plants received from Mungpoo in February, 1947 and the cuttings made from a few of them especially the root cuttings showed the best activity in August when the rainfall was 15.4 inches and the mean minimum temperature was 79.5°F, whilst in November when the rainfall was nil and the mean minimum temperature was 64.6°F they showed definite signs of drying up. As the plants are thriving well at Labdah the source of plant materials, the fall in monthly mean minimum temperature in November may not adversely affect the growth of the plants in the plains. But the difference in atmospheric humidity between August and November might have an influence and the plants were subjected to increased humid condition in November in order to investigate the question. It was found that on increasing the humidity the growths of young plants and cuttings were revived to a great extent as observed by the development of branches and leaves. Thus in November onwards through the winter months the conditions of growth of the cuttings and the young plants, when kept under humid condition, was much better than what was found in August under nursery condition.

The observations indicate the favourable influence of lower temperature of winter months as compared with August provided the humidity is not allowed to decrease. And the mean maximum temperature of the plain appears to be above the optimum temperature for growth of the plants otherwise we would have expected the best growth during the rainy season—rather than in winter months under artificially increased humid condition.

51. Effects of temperature and short day length on acceleration of flowering in winter rice.

S. M. SARKAR and B. N. GHOSH, Calcutta.

Effects of high and low temperatures and in combination with short day length have been studied on two winter varieties of rice, *Bhasamanik* and *Rupsail* in pot culture experiments. The effect of short day treatment of 8 hours for 4 and 6 weeks has also been studied in randomised field plots with one variety, *Rupsail*.

Seeds of *Bhasamanik* and *Rupsail* were soaked in water at the rate of 28 to 30 per cent per fresh weight for 48 hours in order to sprout the embryos. Then the sprouted unsplit seeds were transferred to the incubator regulated at 35°C for 10 and 20 days; for low temperature treatment the sprouted unsplit seeds were kept in the refrigerator controlled at 10°C for 5 days. After high and low temperature treatments the seedlings were grown in seedbed pans with a control set for each variety. One week after, short day treatment of 8 hours was begun. Then the seedlings were transplanted in earthenware pots with 10 replicates for each treatment; altogether there were 400 pots for these two varieties.

Short day followed by low temperature accelerates flowering in the main stem as well in the subsequent tillers of *Rupsail*, while short day treatment alone induces early flowering in the main stem. High and low temperature treatments do not show any acceleration of flowering in these two varieties of rice. Flowering is retarded by high temperature in combination with short day treatment, except in the main stem of *Rupsail* where an earliness is induced with short days followed by high temperature for 10 days only. In the field experiment short day treatment of 8 hours for 4 and 6 weeks shows a marked earliness in ear emergence in *Rupsail*.

52. Effect of age on the regeneration of *Bryophyllum* leaves.

S. PATTANAIK, Balasore.

In the present investigation, the effect of age on the regeneration of *Bryophyllum* leaves has been studied on a quantitative basis. The data obtained in this study point out that the power of regeneration increases with age. Well grown-up isolated leaves proliferate much earlier in comparison to young ones.

Mineral solution has little effect on the regenerating leaves of *Bryophyllum*, though young leaves show a slight increase in the presence of mineral solution.

53. Effect of Hydrogen Ion concentration and salt content of the medium on the development of sett roots in Sugarcane.

R. Narasimhan and N. L. Dutt, Coimbatore.

Unfavourable reaction and salt accumulation are two of the common defects met with in soils which affect the growth of roots and consequently the development of the plant.

A knowledge of root development under such conditions is useful to the Plant Breeder for evolving tolerant strains.

Preliminary studies have been made at the Coimbatore Sugarcane Breeding Station to observe the effect of reaction and salt concentration of the medium on sett root development of certain varieties of Sugarcane.

1. Effect of reaction of nutrient solution ranging from *p*H2 to *p*H11 on sett root development was studied on two varieties of Sugarcane Poovan and Co. 432. The results indicated that optimum pH for vigorous root growth is 50 while there is another optimum at *p*H 9.0 where both the varieties *i.e.*, Co. 432 and Poovan showed good root growth. Co. 432 was found to be more tolerant to variation in *p*H both in the acid and alkaline side than Poovan.

2. The effect of salt concentration on sett root development was studied with three varieties, Red Mauritius, Co. 432 and Co. 419. It was found that 0.20 per cent and 0.10 per cent of salt concentration (NaCl) adversely affected the root development in all the three varieties, Red Mauritius being affected most. With 0.05 per cent salt concentration Co. 419 showed vigorous root growth while in the case of Red Mauritius there was a set back in root growth as compared to the control.

54. Effect of some carcinogenic Hydrocarbons on the mango fruit.

S. C. Agarwal and G. S. Verma, Lucknow.

The effect of four hydrocarbous *viz.* 1,2,5,6. Dibenzanthracene, 9,10 Dimethyl 1,2 Benzanthracene, 1,2 Benzathracene, and Methylcholanthrene in different concentrations was stdudied on two varieties of mango (*dasehri* & *safeda*) by external application on the skin after rubbing with sand paper and by direct injection at the tip of the fruits at various stages of the growth.

Methylcholanthrene was found to be most reactive. 1,2,5,6 Benzathracene also produced some effect while the others showed no visible effect. Direct injection alone, was found to be effective.

Dark brown lesions were produced around the point of injections which showed necrosis of tissues in some fruits, while some escaped with yellowing of the skin alone. Higher concentrations (1%, .01%) were more reactive than lower concentrations. Young fruits have been found to be more susceptible than fully mature ones.

55. Observation on the Sand Vegetation of some parts of Bengal, Orissa and Madras.

K. Biswas and S. K. Choudhuri, Sibpur.

A preliminary study of some of the characteristic sand flora along the sandy shores of Coxbazar (Chittagong), Chilka Lake, and Gangam district in Madras Presidency is reported here.

The species found are only a little over three decades. The phanerogams often form small patches or what may be called ecads or society of their own spreading over the flat or undulating sand dunes. Sometimes *Tephrosia purpurea* grows as a dense impenetrable bush on the top of the sand hills. Notes on systematics, ecology and other botanical aspects of these plants have been incorporated in the paper.

56. Studies on the Plankton flora of River Hooghly with special reference to the working of the filter beds of Calcutta Water Supply.

HIMANSU KUMAR ROY, Calcutta.

Every year during the summer and winter months there is a choking of filter beds due to algal growth which results in a reduced filter water supply of Calcutta. A study was made during last three years to see if the Plankton organisms in the river water have got any direct influence on the working of the filter beds. It has been found that the diatoms play the most important part in the execution of the cycle of seasonal and annual variations of the Phyto as well as total plankton. The maximum yield of the diatoms is recorded during the winter months. The same genus of diatom has not got similar yields during the different years of study. Thus *Melosira* was found to be the most dominant diatom during the years 1945-46 (July-June) and 1946-1947. In the third year, however, *Coscinodiscus* took up the dominant phase. This change of annual dominancy seems to be due to the natural cycle of annual variation which can only be ascertained by collecting for some future years. The protozoa (including all the flagellates and ciliates) comes second to the diatoms regarding its annual dominancy.

The total annual rainfall is seen to have a distinct reverse relation with the yield of plankton. There is a regular increase every year in the average annual yield of the diatoms expressed as percentage of the phytoplankton yield. Thus the phytoplankton is more and more represented by the diatoms (sea-water organisms) as the successive years pass on, the Hooghly water thus approaching the characters of sea water. This is also supported by the regular increase of the yearly average of the salinity of the river water. The river water has got the highest dissolved oxygen content during the winter, the period of maximum phyto-plankton yield. This seems to be due to increased photosynthesis. The optimum temperature for the growth of diatoms is found to be near about 20° C.

The growth of diatoms mainly of the Centricae group in the river water seem to be directly responsible, with or without some other organisms of the Schizophyta, for the chokage of the filter beds during the winter. This is also supported by the findings of the direct microscopic observation of the sand from a choked filter bed. But the chokage during the summer when the growth in river water is almost negligible, seems to be due to growths of diatoms such as *Synedra* etc., with or without some other organisms, intrinsic to the settling tank and filter beds. This will be discussed elsewhere.

57. A comparative study of meadows.

R. MISRA, Saugor.

The study comprises floristic and environmental details of five meadows with a similar appearance, at Saugor.

The area of the quadrat used for sampling was determined by the species-area curve method. It was to be 0.16 sq. meter. Ten samples of this size were taken at random in each meadow for the determination of frequency, density and cover of the species. These are correlated with physiographic, biotic and edaphic factors obtaining in the meadows.

Out of a total of 53 species, only one was found to be common to all the meadows and 9 were found in four of them. Lists of species with preferences for soil types regarding depth, leaching and erosion, grazing, etc., are drawn from the study with relevant discussion.

58. A preliminary survey of the vegetation of Saugor Lake.

R. MISRA and J. P. SHRIVASTAVA, Saugor.

The physical features and the macrophytic vegetation of a large lake at Saugor, C.P., are described in this paper. The vegetation is grouped into four associes, *viz.;* (i) the deep water submerged associes, (ii) the shallow water submerged associes, (iii) the floating leaf-form associes and (iv) the amphibious marsh associes. The species belonging to each of these are listed with their frequency-abundance, and factors affecting their growth are discussed.

59. The vegetation of Saugor University plateau.

R. MISRA and S. C. PANDYA, Saugor.

The characteristics of the plant communities showing strong seasonal phases as are found on terraces and slopes, along buildings and gullies and drains, of the plateau are given in the paper. An analysis of the habitat factors reveals striking correlations between the incidence of species and edaphic factors. The results of the study are illustrated with maps and charts.

60. Notes on the Autecology of *Anisochilus eriocephalus* Benth.

R. MISRA and TRILOCHAN SINGH, Saugor.

Anisochilus eriocephalus Benth. (Family-Labiatae) grows gregariously on tiled roofs in Saugor and neighbouring villages. The plant is an annual appearing in the rainy season and completes the life cycle before the end of October. The seed output is large but the percentage germination does not exceed 12 and seedling mortality is very high. The factors affecting each of these stages in nature have been studied in the field and by means of culture experiments in the laboratory. It is found that the plant is susceptible to waterlogging and interspecific competition on account of which it is driven to sloping roof of houses.

61. Ecological problems of the humus layer in English forests.

G. S. PURI, Dehra Dun.

On the basis of characteristic ground flora communities and associated tree seedlings, humus layer in some broadleaved forests in the south of England (Whippendell woods, Box Hill, Tring and Moor Park) was classified into three main types. These classes correspond broadly to P. Mullers' well recognised biological types-Mull and Mor-with types intermediate between the two extremes.

The ground flora communites and seedling growth was found to be intimately related to .the whole complex of soil conditions rather than to any single factor. This confirms Pearsall's conclusions about the North England forests, and also indicates their applicability equally to the forest of South England.

The different types of soil recognised in these woods were found to be related to topography, tree vegetation and worms. Broadly speaking, soils at lower levels were mull with large worms, while mor or transition-to-mor soils were usually observed at upper levels. Worms were either absent or were very few in numbers in the latter type of soils.

Tree vegetation was found to have a far greater influence on the development of the humus layer. By virtue of their capacity to absorb minerals from deeper layers and bringing them to surface of the soil, trees on the whole tend to keep minerals in circulation and militate against the loss of leaching. Thus, the chemical composition of litter, which determines its palatability to worms and rate of decomposition in Nature, assumes great importance in determining the soil types. Tree litter with a high C : N and a high C : line is not only less readily eaten by worms but its decomposition under natural conditions is slow. Litter of low C : N and a low C : lime on the other hand, decomposes faster and is palatable to worms. The rapid decomposition of litter releases plant foods as nitrates, and minerals which not only act against soil acidity but maintain a high base status of the soil and produces fertility conditions in forest. The accumulation of litter on the other hand, accentuates leaching; does not liberate plant foods and so makes the soil infertile. Thus, trees with high lime requirements and low C : N tend to increase soil fertility forming mull soils of high reproductive capacity; while those with low lime requirements and a high C : N generally result in unproductive conditions and mor soils.

The regeneration of forest trees is intimately related to soil types and soil fertility. Thus, a greater number of English forest trees *e.g.*, ash, cherry, hazel, oak and even beech grow as seedlings on mull soils. The only species regenerating on mor soils are pine, birch and mountain ash. The soil fertility is, thus, of utmost importance in regeneration and successful establishment of a forest. In the damp climate of Britain the general trend of soil development is one of decreasing soil fertility with advancing age. The importance of species like ash, hazel and cherry which maintain soil fertility and condition forest regeneration can not be over emphasised for successful silviculture in that country. The danger of planting conifers is obvious.

62. Surface Geology, vegetation and plant succession in the London Basin,

G. S. Puri, Dehra Dun.

This stduy was conducted on the soils and vegetation of the London basin, which is a syncline bounded on the North by Chilterns Hills and on the South by the North Downs. The dominant rock in this region is the Chalk, masked by clay-with-flints and deposits of later geological ages. These deposits consist of clays, sands, loams, gravels and alluvials which were derived mainly from rocks not particularly rich in lime. They are variously exposed and in the centre of the syncline make up all or the major part of the surface soils, the strata of the Chalk seldom affecting the vegetation.

Five examples were studied, two (Box Hill; and Tring) on the scarp slopes and three (Epping Forest; Whippendell woods and Oxshott) on the dip slope of the Chalk.

On the slope of the chalk escarpment the soil is usually immature and rich in lime. On account of the characteristic topography and composition of the rock it is obvious that a high base status of the soil would be maintained along this slope. On the dip slope, however, the surface soils being made up of leached residues of chalk or deposits of reassorted material, are lime deficient. These soils must have been rich in bases when immature but they have now attained stability and are leached of minerals.

The soils on the two slopes of the chalk are thus, fundamentally different and would be expected to bear distinctive vegetation types.

The vegetation on the *two slopes* was found to be distinct and the following account shows a clear relation of the vegetation with the geological features.

(1) Ash and beech communities as a rule are confined to *scarp slope,* while Oak is the chief type on the *dip slope.*

(2) On immature soils of the scarp slope ash forms a seral community usually on lower levels. Its presence in valleys or elsewhere on the dip slope is associated with similar types of soil provided locally by patches of Glacial Gravel, Silty loam or an outcrop of the chalk. On account of the low lime content of the soil and intensity of leaching the ash community here seldom remains in a seral stage and either develops into an edaphic association of ash-oak-beech or is succeeded by an oak wood.

(3) Similarly, beech normally forms a seral community on the scarp slope at situations on valleysides on the dip slope. In local patches of Sand or Pebble Gravel or in disturbed Oak woods on the dip slope beech forms an oak-beech community. Again, depending upon the lime content of the soil and intensity of leaching the oak-beech either reproduces itself as an edaphic association or is succeeded by beech probably. finally degenerating into a heath.

(4) On the *dip slope* of the Chalk, Oak is a leached edaphic climax reproducing itself naturally. On sands or in areas from where oak woods have been clear-felled vegetation burnt, birch community originates. It is, however, succeeded by Oak and or Oak → Beech heath.

The forest vegetation in the London Basin can be viewed as a series of successions in the general sequence:-

Mixed deciduous colonising woodland → oak wood → Heath, in which the early seral stages are preserved by (i) geological features (nature of rock and the amount of Calcium (ii) by immature topography-scarp slopes *versus* dip slopes (iii) by location of accumulation areas and (iv) by biotic influences.

ECONOMIC BOTANY

63. Common paper yielding plants of India.

K. BISWAS and BAZLI ALI, Sibpur.

Scarcity of paper since the war and even the present post-war period prompted the authors to investigate into the raw materials available in India. A systematic list of the common paper yielding plants has been drawn up and the range of distribution of each of the species worked out. Field experiments are being carried on with a view to improve the most important crop of the paper yielding plant materials namely *Dendrocalamus stictus.* Notes on the possibilities of large scale cultivation of other more important paper plants for the manufacture of hand-made paper as a home industry have also been incorporated in the paper.

64. *Cephaelis ipecacuaunha* (Brot) A. Rich.—The emetine yielding plant, its Botany and scope for cultivation in India.

K. BISWAS and M. A. SAMPATH KUMARAN, Sibpur.

The well-known medicinal plant-Ipecacuanha, a native of Brazil is accepted and used as a specific against dysentery for the last 200 years. There exists therefore, considerable literature on the Botany and the experimental cultivation of this emetine yielding plant. In India experimental cultivation and botanical investigation were undertaken as early a period as 1886 by Sir George King, the then Superintendent, Royal Botanic Garden, Calcutta and was subsequently pursued by his successors. The results obtained so far from the study and trial cultivation of this delicate plant led to the introduction and successful cultivation of the authentic species in the lower hill forests of Sikkim-Darjeeling Himalaya and the Nilghiris. The authors in this paper have discussed the possibilities of cultivating this plant on an extensive scale in suitable areas in India with a view to meeting the great demand for this plant and have also dealt with its ecology, morphology and systematics against the background of the past researches.

PALEOBOTANY

65. *Dadoxylon eocenum* sp. nov. from the Chhindwara District (C.P.).

MRS. S. D. CHITALEY, Nagpur.

The specimen described in the present paper is a piece of Coniferous wood, mostly secondary, collected from the Chhindwara District (C.P.).

It is characterised by distinct, narrow growth rings, resiniferous tracheids; radial pits bordered, 1-3 seriate, sometimes in groups of 2-5, contiguous hexagonal, sometimes opposite; tangential pits present, bordered, scattered, sometimes 1-2 seriate, alternate; medullary rays 1-2 seriate, 1-15 cells high, average height 4 cells; pits in the field 1-7, bordered or simple.

On the basis of the anatomical details, the specimen has been referred to the genus *Dadoxylon.* Comparisons have been made with all the known species of Southern *Dadoxyla* and also with *D. (Mesopitys) Tchihatcheffi,* the solitary species from the Northern hemisphere, and it is concluded that this specimen differs from all the others in one respect or the other. It shows maximum resemblance with the following five species, but again differs from them in the characters given against each of them respectively:—

D. bengalense, Holden: differs in the nature and height of the medullary rays, and in the no. of field pits.

D. sp. b. Sahni: differs in the nature of the medullary rays and in the absence of uniseriate radial pitting.

D. Arberi Walton: differs in the height of the medullary ray, the no. of the field pits and in the absence of the tangential pits.

D. resinosum Shukla: differs in the seriation of the radial pits (being 1-4), height of the medullary ray, and the no. of the field pits.

D. Chandaensis, Chitaley: differs in the height of the medullary ray, and the no. of field pits, and in the presence of fungus like inclusions.

Since the species is different from any other type hitherto known, it is proposed to name it as *D. eocenum,* the specific name referring to the Eocene beds of C.P., from where it has been discovered.

66. Microfossils of Laitryngew Coal Seam and the Age of the Cherra Sandstones.

J. SEN, Calcutta.

An attempt has been made to approach the problem of the age of the Cherra Sandstones by micro-botanical examination of a few coal samples from the associated Laitryngew seam, as an independent line of enquiry. Abundance of angiospermic remains represented by the pollens of *Magnolia,* oak, date palm, some wood fragments etc., and scanty occurrence of gymnospermic elements indicate a Tertiary age for the Cherra. But more extensive work is necessary to substantiate this conclusion. The pteridophytic fragments are very few. The presence of Magnolian, oak, and coniferous (?) pollens further suggest that the flora is of temperate nature, and that of palm shows a relationship between the formation of the beds and arid condition. This fact has been substantiated from other geological evidences.

About 23 species of pollens and spores, and several wood fragments and cuticular structures have been described and their affiinities discussed. Some of these findings provide a valuable ground for research regarding the suggested origin of scalariform from pittings and reticulation.

PHARMACOGNOSTIC BOTANY

67. Pharmacognostic studies on commercial varieties of *Rauwolfia serpen-*

S. C. DATTA, Calcutta.

The paper deals with the morphological and histological characters of the roots of different samples of *R. serpentina* roots collected from different parts of India as well as the roots of *R. canescens* Linn. which often grow side by side with *R. serpentina* and is used as a common adulterant. There is a good demand for genuine *Rauwolfia serpentina* roots due to its action as a sedative drug. It lowers blood pressure and stimulates uterine movements as well as the plain muscles of the gastrointestinal tract. For distinguishing between the roots of the different samples, the following factors were taken into account, *viz.*, macroscopic and microscopic characters including quantitative microscopic measurements of cells and tissues, measurements of starch grain diameters, their mean and range, determination of starch grain index, determination of number of cork cells per square millimetre, and measurements of lengths of xylem vessels. It was found that *R. serpentina* and *R. canescens* roots could be easily distinguished by taking into account starch grain index or number of cork cells per sq. mm. or xylem element length or histological details. The distinction between the different collections of *R. serpentina* roots was, however, more difficult and it could only be accomplished by a careful consideration of starch grain index. *i.e.*, the percentage of starch grains having diameters greater than a certain limit. It was also found that this factor is dependent on the diameters of the roots and consequently on the age of the specimens. Five varieties of *R. serpentina* roots, *viz.*, Bengal, Bihar, Dehra Dun, Assam and Ceylon were taken into account. The different samples vary in their constituents and the Bihar sample is reported to be rich in Serpentine group whereas the Dehra Dun variety is rich in Ajmaline group.

68. Kurchi Bark and its adulterant.

D. DATTA and AMIYA DATTA, Calcutta.

This paper deals with the comparative pharmacognostic studies of the barks of *Holarrhena antidysenterica* Wall and *Wrightia tinctoria* R. Br., a common adulterant of *Kurchi*. Comparative macroscopic and miscroscopic examinations of the two barks have been studied. The main points of differences are the absence of fibres and presence of less thickened wall and bigger lumened stone cells in *Kurchi* (*Holarrhena antidysenterica* Wall). The fibres of *W. tinctoria* have cellulose walls.

SECTION OF ZOOLOGY AND ENTOMOLOGY

PRESIDENT: DR. M. L. ROONWAL, M.Sc., Ph.D., (Cantab), F.N.I.

1. Further report on the survey of the marine fauna of Karwar.

A. M. PATIL and P. W. GIDEON, Dharwar.

The paper is a more detailed study based on further collections made at different seasons of the year.

2. Nucleic acid sycle and the time of division of the heterochromatic sex-chromosome of the grasshopper, *Attractomorpha* sp. (Acrididac).

S. P. RAY CHAUDHURI and IRA BOSE, Calcutta.

The nucleic acid cycle of the sex-chrmosomes of *Attractomorpha* sp. (male) throughout the different stages of spermatogenesis has been studied. The sex chromosome being heterochromatic is over-charge with nucleic acid at the resting stage of the early spermatogonial cells and progressively becomes denucleinated. It, therefore, reaches the metaphase stage undercondensed. The ever-consideration of the heterochromatin at the resting stage is due to the process of nucleic acid attachment starting at the previous divisional cycle at a stage when there was an abundance of supply of nucleic acid in the cell due to the denucleination of the euchromatic autosomes. The differential behaviour of heterochromatin and euchromatin is no longer present in the late spematogonial divisional stages but becomes apparent again in meiosis. The nucleic acid cycle also determines the time of division of the sex chromosome in meiosis. It divides at the resting stage just preceding meiosis when its nucleic acid charge is minimum.

3. Multiple sex-chromosomes and their determinate disjunction in the grylid, *Euscyrtus* sp.

S. P. RAY CHAUDHURI and G. K. MANNA, Calcutta.

X_1X_2 Y mechanism of sex determination in the *Euscyrtus* sp. is now being reported for the first time in the Gryllidae. The most interesting feature of the behaviour of the sex-chromosomes is that they never associate in the prophase of meiosis. Apparently the Y does not contain regions homologous to parts of both the X's and, therefore, chiasma formation, leading to the formation of sex trivalent is impossible. The sex-chromosomes attach themselves near the two poles of the spindle, in the metaphase stage of the first division of meiosis, in such a way that during disjunction, the Y goes to one pole and the two X's to the other. The Y apparently determines the disjunction of the X chromosome complex or *vice versa*. The probable mechanism of the evolution of multiple sex-chromosomes in this species has been discussed. The sprematogonial cells of the testis and the follicular epithelial cells of the ovary show that the number of chromosomes in the species is $2n = 19$ in the male and $2n = 20$ in the female.

4. Effect of cold treatment on the frequency of non-homologous chromosome association in the grasshopper, *Catantops trisinteressonute* (Acrididae).

S. P. Ray Chaudhuri and K. K. Manna, Calcutta.

A varying number of non-homologous chromosomes in the spermatogonial and spermatocyte nuclei of untreated males of *Catantops trisinteressonute* possesses inter-chromosomal thread-like connections which are Feulgen positive. During meiosis, about 60% of the diplotene nuclei are found thus 'affected'. The total number of connections and the percentage of nuclei having associations gradually diminish with the advance of meiosis. The associations are not entirely at random, the sex-chromosomes being the main centre of association (47.9% of the association involves the sex-chromosome).

Males of the species were kept at I°C for 72 hours before their testis were fixed for study. The data obtained conclusively prove that cold treatment increases the frequency of affected nuclei as well as the frequency of interbivalent connections in the diplotene, diakinesis and metaphase stages of meiosis. The total number of affected nuclei in the three stages in the chilled preparations is 102 out of a total of 163 (62.6%) nuclei studied as against 53 out of 163 nuclei (36.2%) in the controls.

The above results strongly indicate that the non-homologous associations are really heterochromatic association, and this is due to defect in the nucleic acid matabolism of the heterochromatin. Some of the heterochromatic segments of the chromosomes ordinarily have normal metabolism, but cold treatment perhaps interferes with the process of polymerization of the nucleic acid in these segments thus rendering them sticky. The above hypothesis helps us in explaining the increase in the frequency of non-homologous association found in the chilled preparations.

5. On the behaviour of a supernumerary chromosome in the chromosome complex of some individuals in the natural population of the grasshopper, *Aiolopus* sp. (Acrididae).

S. P. Ray Chaudhuri and G. K. Manna, Calcutta.

Two male individuals out of a total of 26 specimens of *Aiolopus* sp. examined, from the field adjoining the Biological Laboratories of the Calcutta University, contain a small extra chromosome. Its size and behaviour during meiosis in both the specimens are similar. Mitotic metaphase complement in the spermatogonial cells shows clearly 24 chromosomes instead of the usual 23 in the normal males, and the supernumerary appears a little understained. At diplotene and diakinesis the supernumerary and the X lie as univalents and often the two are very closely associated. At metaphase of the first division the former may lie either on the equatorial plate of the spindle along with the bivalents or may form an accessory plate similar to that of the sex-chromosome. When both of them form accessory plates, the supernumerary may lie either along with the X or on the opposite side of the spindle, the frequecy of the two types of arrangements being about equal. In the first division anaphase it passes undivided to one pole of the spindle and divides equationally at the second division.

6. Meiosis in the Hemipterans *Sphaerodema sp.* (Belostomatidae) and *Riptortus* sp. (Coreidae).

S. P. Ray Chaudhuri and J. Das Gupta, Calcutta.

The spermatogonial chromosome complement consists of 28 and 13 chromosomes in *Sphaerodema* sp. and *Riptorus* sp. respectively, the former having an XY mechanism of sex-determination, the latter XO. The sex-chromosomes in both the species divide equationally in the first and reductionally in the second meiotic division. A pair of m-chromosomes characteristic of Hemiptera are present in the two species, but their behaviour during meiosis is different. In *Riptortus* the two m-chromosomes always associate at the zygotene stage and thereafter behave quite differently. During diplotene and diakinesis, in about half of the nuclei, the m-chromosome lie far apart, whereas in the other half they are associated. In spite of the above, their disjunction is quite normal and they segregate to the oppsite poles regularly at the first anaphase stage. The m-chromosomes in *Sphaerodema,* on the other hand, behave more or less like normal autosomal bivalents throughout meiosis.

7. The chromosomes in three species of Indian dragonflies.

S. P. Ray Chaudhuri and J. Das Gupta, Calcutta.

The diploid chromosome number in the males of *Rhyothemis variegata, Brachydiptax sobrina* and *Neurothemis tulia tulia* are 25, 25 and 28 respectively. The last named species have an XY mechanism of sex-determination, whereas in the other two it is XO. The second meiotic division is reductional for the sex-chromosomes in all the three species.

8. Responses of the genital system of female spotted munia, *Uroloncha punctulata* (Linn.) to *a-estradiol* benzoate.

Amiya B. Kar, Calcutta.

Intramuscular injections of *a-estradiol* benzoate (125) R. U. daily) into juvenile Spotted Munia, *Uroloncha punctulata* (Linn.), induced considerable hypertrophy of the oviduct. Concomittant with the precocious enlargement, the oviduct showed pronounced histological changes. Stratification and ciliation of the epithelial layer of the mucosa were experimental alterations of considerable interest. The mucosal folds were extremely prominent; the tubular glands were greatly developed; the connective tissue stroma and the muscular layers were greatly hypertrophied. Hyperemia was definitely indicated. The ligaments of the oviduct were greatly enlarged in the treated birds and exhibited thick muscular bundles. The ovaries were not affected by estrogen treatment. This lack of action of the hormone on the ovary is explained on the basis of non-involvement of the pituitary.

9. On a *Monocercomonoides nimiei* n. sp., from the caecum of Indian Guineapig, *Cavia cutleri* Bennet.

D. K. Ray, Mukteswar.

A new flagellate *Monocercomonoides nimiei* n. sp., is described from the caecum of *Cavia cutleri Bennet.* Flagellates are round or oval in shape, 3 11 in length and 1.5- 45 in breadth. The pellicle is thin. The nuclear memberane is not prominent while the karyosome is distinct. Two blepharoplasts are situated on either side of the nucleus and are connected with each other by a paradesmos. From each blepharoplast originate two flagella. The fourth flagellum is longer than the rest, and both in the fresh and stained specimens is found to be trailing behind. A siderophilic axoneme originates from the blepharoplast (which also gives origin to the trailing flagellum), passes posteriorly and sometimes extends beyond the body. In silver preparations a dot-like parabasal body was found to be situated on the lower side of the nuclear membrane. A structure similar to "Pelta" of trichomonads was also encountered for the first time in the flagellates of the genus *Monocercomonoides.*

10. On a new flagellate *Prowazekella hareni* n. sp., from the caecum of Indian Guineapig, *Cavia cutleri* Bennet.

D. K. RAY, Mukteswra.

In the caecal material of Indian Guineapigs, *Cavia cutleri* Bennet, a new flagellate, *Prowazekella hareni* n. sp., was encountered. In fixed and stained preparations the body of the flagellate averages 9.5 × 2.9 . At the anterior end there is a small protruberance where the blepharoplast is situated and from which the two flagella arise. The anteriorly directed flagellum is much thicker than the one directed posteriorly.

Both the flagella are of equal length and correspond to the length of the body. The "Pelta" is situated just below the blepharoplast as a horizontal rod-shaped structure. It is for the first time that "Pelta" has been encountered in the flagellates of genus Prowazekella. The ring-shaped parabasal body is placed just above the nucleus. The rhizoplast passes through it to the nuclear membrane. The nucleus is situated at the anterior end; it contains several chromatinic granules, while the nuclear membrane is not prominent. The cytoplasm is alveolar, with a thin pellicle.

11. On a new Coccidium, *Eimeria petauristac* n. sp., from the intestine of Himalayan Flying Squirrel, *Petaurista inornatus*, (Geoff.).

H. N. RAY and HARBANS SINGH, Mukteswar.

A new coccidium, *Eimeria petauristae* n. sp., is described from the Himalayan Flying Squirrel, *Petaurista inornatus* (Geoff.), The *Oocyst* is flask-shaped and is covered with a thick and rugged outer covering which is deep brown in colour. It is 46.25—52.5 long and 35.0—40.0 μ broad. The oocystic residue is small and central in position. The anterior end of the oocyst is drawn out in a short neck-like elongation and shows a dome-shaped pseudomicropyle. The dome of the micropyle often projects beyond the thick outer covering. When freed from the outer covering, the oocyst is colourless. Sporocysts are naviculoid in shape with one pole slightly broader than the other. There is no polar, papilla. Each sporocyst is 27.5—31.25 long and 8.75—10.0 broad. The sporocystic residue is large as compared to the oocystic residue. The sporozoites are elongated, with a broad anterior pole containing a few refractile granules. When treated with trypsin the sporocyst gave way at the narrow pole and the sporozoites wriggled out with this broad end uppermost. Attempts to infect rabbits with *E. petauristae* n. sp. gave negative results. Saturated sugar solution, saturated salt solution and zinc sulphate failed to float up successfully the oocysts of this coccidium.

12. Some new species of Cestodes of the marine fish *Rhynchobatus djeddensis* (Forsk) from Bombay.

D. V. BAL and F. S. KHAMBATA, Bombay.

Specimens of *Rhynchobatus djeddensis* from the Bombay waters were heavily infected with parasites and contained, in the spiral valve, many species of Nematodes, Cestodes and Trematodes. Of these, the first two were more abundant.

The Cestodes, which have been studied during the last three years, consist of 25 species. Twelve of these species, belonging to the following six genera, appear to be new to science and are described in this paper:—1. *Tetrarhynchus* Rudolphi, 1809. 2. *Tentacularia* Bosc, 1797. 3. *Phyllobothrium* van Beneden, 1850. 4. *Echeneibothrium* van Beneden, 1850. 5. *Acanthobothrium* van Beneden, 1850. 6 *Tylocephalum* Linton, 1890.

13. Occurrence of Polychaetes in fresh water in the river Godavari.

K. H. Alikhni, Madras.

Records of purely freshwater Polychaetes are rare, though several species are known to inhabit backwaters and estuaries and tolerate extreme fluctuations in salinity. While investigating the fisheries of the river Godavari during July 1948, a single specimen of *Nereis* sp. and seven specimens of *Nephthys* sp. were collected in fish fry nets, the former at Kotipalli (15 miles from sea) and the latter at Rajamundry (60 miles from sea) and Polavaram (84 miles from sea). The river was in spate, with turbid water and the worms were apparently swimming with the current. The physico-chemical conditions of the water at the time of collection and on previous occassions when the localities were visited, were recorded. The water at Polavaram and Rajamundry is completely fresh all the year round, and the occurrence of these worms, particularly of *Nepthys* sp., in purely freshwater is of interest.

14. The brood-pouch and nutrition of embryos in *Melanoides tuberculatus* (Muller).

K. Ramamurthy, Annamalainagar, (S. India)

Melanoides Tuberculatus is a common Melaniid gastropod, in which the ova undergo development in a brood-pouch, the young animals coming out of the mother with a form completely resembling the adult. In gravid females the brood-pouch epithelium shows a striking transformation of its cells. which become secretory Microchemical tests show the presence of fat, vitamin C and copper in them. The cells project out into the brood-pouch and finally get detached. The brood-pouch is filled with an albuminous fluid in which float some of the epithelial cells filled with secretory globules. The nutrition of the embryos in later stages is effected by the transformed epithelial cells of the brood-pouch.

15. Diatoms in the food of the Madras Oyster, *Ostrea madrasenis*, Preston.

P. K. Jacob and M. Nellayandar.

To determine the availability of food in the Ennur oyster beds and to bring out the part that the diatoms play in the Madras Oyster, regular plankton collections were made from beds, simultaneous with the examination of stomach contents of the oysters for a year. Great similarity in these two items showed that the diatoms constitute a major portion of the food of the oyster. The various species of diatoms and other microorganisms forming the food of this oyster are enumerated. The probable part that the inorganic detritus plays in the nutrition of this oyster is also discussed. The importance of diatoms as a fattening factor in oysters, as was found in the Thames and Fal Estuaries, was noticed here also.

16. Reproduction, growth and development of the Madras Oyster, *Ostrea madrasensis*, Preston.

P. K. Jacob and M. Nellayandar.

The reproductive organs, spawning season and the mode of fertilization of the Madras Oyster, are described. The method used for artificial fertilization of this oyster is described and the early developmental stages up to the third day are noted. After 12 days a spat was noticed on the side of the aquarium. The characters of this spat, its subsequent growth and the temperature, pH and the salinity of the media in which the oyster was growing were also noted. To find out the surface most suitable for spat attachment, glass, porcelain plate, wood and tiles were tried. The maximum attachment was found on wood. By erecting a concrete post on the oyster bed the place of attachment was found to be confined between high and low water, the mid tide being the place of maximum fixation; a clean surface was necessary for attachment.

17. *Two Dipteran Ectoparasites from a bat.*

D. V. BAL and F. AHMED, Bombay.

The frugivorous Indian bat, *Rousettus leschenaulti* Desm; is found in large colonies on the Bombay and Salsette Islands. During our investigations nearly all the specimens collected were found to be heavily infested with a number of external parasites. Of particular interest were a number of flies, which are recorded to be of common occurrence under similar conditions. Two of these flies, *Eucampsipoda hyrtli Kolenati* and *Nycteribosca gigantea* Speiser, described as wingless and winged forms were taken for morphological studies and this paper deals with the external morphology of these two forms.

18. Effect fo transplantation of the physogastric queen of the termite, *Pdontermes redemannt* (Wasmann).

D. MUKERJI and PRABHAS KUMAR MITRA, Calcutta.

Two series of experiments were carried out to note the effect of removal and subsequent implantation of the physogastric queen and king in the 'trophoric field' and in different nest, far off from the original nest. Observations indicate: (i) The presence of the implanted pair is very quickly detected in the trophoric field by the foraging batches (obviously of a different colony). (ii) Construction of a new royal chamber is immediately taken up around the implanted pair. (iii) Implantation of royal pair (from a different nest) within a new termitarium does not disturb the societal life of the latter. The implanted pair receives immediate care and attendence.

19. On the structure and post-embryonic development of the male genital organs of the Wolly Bear, *Anthrenus fasciatus* Herbst (Coleoptera, Dermestidae).

K. S. PRADHAN, Banaras Cantt.

The external genitalia of *Anthrenus fasciatus* consist of an aedeagus, a pair of parameres, a basal plate and a *spiculum gastrale.* All these structures originate from a pair of primary lobes which develop from the terminal segment. Each primary lobe divides into two. The inner member of each pair fuses to form the tubular ædeagus, while the outer member gives rise to the parameres. The parameres, therefore, develop as distinct morphological entities and are not merely outgrowths of the aedeagus. The *spiculum gastrale* develops from the fused mass of aedeagus and parameres. The basal plate originates from the fused mass of the parameres when all the other elements have been formed and separated off.

Each testis consists of six cylindrical follicles. The *vasa deferentia* are evidently mesodermal in origin and extend upto seventh abdominal segment in the early stages, but in the later stages of development they extend upto the fifth segment. The accessory glands, of which there are two pairs, are ectodermal in origin and develop from the lateral ejaculatory ducts. The lateral ejaculatory ducts arise from the median ejaculatory duct, the latter developing as an invagination of the ectoderm from the ninth segment. The terminal gonopore lies at the apex of the aedeagus.

20. On the physiology of digestion of the larva of Wolly Bear, *Anthrenus fasciatus* Herbst (Coleoptera, Dermestidae).

K. S. PRADHAN, Banaras Cantt.

The larvae of *Anthrenus fasciatus* live on scleroproteins and digest the keratin substance which forms the chief constituent of the ingested food. When the larvae feed on the coloured wool of commerce the pigment material is also absorbed but the absorption takes place only in traces, and the major portion of the pigment is passed out along with the faeces. The granular faeces contain traces of keratin and an appreciable amount of urea, uric acid, ammonia, urates, and sulphates. The phosphates are present in the excrement only when the larvae feed on horn.

Qualitative tests were made for the ferments pepsin, trypsin, erepsin, chymosin, lipase, catalase, amylase, cellulase and invertase, and the methods used in preparing the extracts for detecting them in various regions of the gut are described. The presence of the ferments trypsin, erepsin, chymosin, lipase and catalase has been detected in the region of the mid-gut. It has been concluded that the fore-and hind-guts are incapable of producing the ferments.

The nutrition of the larvae is discussed on the basis of the experimental results with respect to the chemical analysis of the faecal granules and the ferments detected in the region of the mid-gut.

21. Notes on the life-history of *Labeo calbasu* and *L. fimbriatus.*

K. H. ALIKUNHI, S. V. GANAPATI and S. NAGARAJA RAO, Madras.

The spawn and hatchlings of *Labeo calbasu* were collected in large numbers from the R. Godavari at Bobberlanka on 22-7-48, transported to Madras and reared in the laboratory. The present note supplements the recent contribution of Mookerjee & Mazumdar (1946) on the development of this carp. The *hydrological conditions* of the water during *spawning* were as follows: Colour—deep brown; turbidity 1.5 cm.; temperature—27.2°C., saturation of dissolved oxygen 83.52%; pH—8.2; and chlorides 0.1 parts per 100,000.

The age of the embryos collected indicated spawning at all hours of the day. The size of the fertilized egg varied from 5.3 to 6.0 mm. in diameter. The period of incubation was about 19 hours. The 4.2 mm. long hatchling was transparent, without pigment in the eyes, and had no mouth or pectoral rudiments. The absorption of yolk was completed by the third day, when feeding commenced. All the fins were fully differentiated by the twentieth day when the fry was 16.5 mm. long. The caudal spot, which is the most characteristic feature of the fry, was conspicuous even at the 12.5 mm. stage. The peculiar pigment patterns were well laid by the twenty-seventh day when the fry was 21.5 mm. long.

The spawn of *L. fimbriatus* was collected from the Cauvery at Bhavani in June 1948, and the development followed. Its postlarval growth was elucidated by rearing the fry collected from the Godavari as well as the Cauvery.

Certain interesting observations on the relative growth of different fry of the same age and subject to identical conditions are also discussed.

22. Observations on the bionomics and post-larval development of the Carnatic Carp, *Barbus carnaticus* (*Jerdon*).

K. H. ALIKUNHI and S. NAGARAJA RAO, Madras.

This carp, which has excellent sporting qualities, is in digenous to the Cauvery system. A systematic analysis of its natural food was made and over 30 items, including aquatic macrophytes. filamentous and unicellular (green and blue-green) algale, diatoms, desmids, sulphur bacteria, planktonic crustacea and insect and fish remains, found in the gut were quantitatively estimated to ascertain the 'tastes' and 'preferences' of the species. Available data indicates attainment of sexual maturity in the first year of life, when it is only 6 to 8 inches in length. Breeding coincides with the monsoon months. A complete series of post-larval stages has been collected from the R. Cauvery. Specific characters for the field identification of the fry and fingerlings are described. Growth in lentic waters has been found to be slow.

23. Metamorphosis of *Elops indicus* Swainson, with notes on the metamorphosis of *Megalops cyprinoides*, (Broussonet).

K. H. ALIKUNHI and S. NAGARAJA RAO, Madras.

The ceptocephalus stages of *Elops indicus* and *Megalops cyprinoides* entering the backwaters from the sea were collected in large numbers at Adyar, near Madras, from 5th to 15th October, 1947.

The following are the chief features of metamorphosis in the two species: *Elops indicus*: The youngest stage collected measured 39.0 mm. long. Flat, ribbon-shaped and fully transparent, it had 62 mytomes; the embryonic fin folds were present in front of the dorsal and anal fins which were not fully differentiated. Metamorphosis was completed in the course of 20 days during which period a progressive reduction in the length and height of the body took place; a gradual loss of transparency was noticed; there was a forward migration of the dorsal and anal fins and of the vent; a noticeable increase in the size of head and accumulation of dark pigment on the snout and on the margin of the dorsal fin were characteristic.

Megalops cyprinoides: The earliest stage collected were 21.5 mm. long and had 68 myotomes; the rudiments of ventrals were present; the embryonic fin folds had disappeared and the air bladder was conspicuous. They metomorphosed in 20 days when body become opaque, shorter and less flat. A forward migration of vent and dorsal and anal fins was characteristic, as in *E. indicus*. These observations confirm those of Hollister (1939) and Chidambaram & Menon (1947).

The post-larval growth of both the species was followed and the data gathered are discussed.

24 On the spawning of carps in the South Indian rivers.

S. V. GANAPATI and K. H. ALIKUNHI, Madras.

Spawn and hatchlings of the major carps of South India have been collected in large numbers from the bigger rivers such as the Godavari, Thungabhadra, Cauvery, Bhavani and Moyar, at different seasons during the last 3 years. The conditions under which spawn was collected can be broadly classified under two heads—flooded and non-flooded. The quality of spawn collected and the physico-chemical conditions existing in the river at the time of collection are described. It is shown that *L. rontius* could spawn in the Cauvery, Bhavani and Moyar at temperatures of 22.3—24.6°C., pH. of 6.6—7.8, and at different times of the day. Likewise, *L. fimbriatus, Labeo* sp., *Cirrhina reba, Garra lamta,* and *Bagarius* sp., spawn in turbid and non-turbid waters equally well. The water was never of found supersaturated with dissolved oxygen. Neither turbidity, temperature, pH., nor dissolved oxygen, therefore, seems to be of any special significance in inducing spawning of these carps. The availability of suitable spawning grounds, either in the river or outside, during the right season when the fish is sexually ripe, appears to be the chief factor responsible for spawning.

25. Experiments on the acclimatisation of saltwater fish seed to freshwater.

S. V. GANAPATI and K. H. ALIKUNHI, Madras.

Job & Chacko (1947) while briefly indicating the prevalent practice, in Madras, of the acclimatisation of saltwater fish seed to freshwater, have not detailed the exact physico-chemical conditions of the water. An attempt is made in the present paper to elucidate the physico-chemical variables in the medium during the several stages of transition from salt to freshwater. Detalis of laboratory and field experiments, carried out during the last 3 years, in respect of early fingerlings of mullets (*Mugil cephalus* and *M. sehelii*), *Megalops cyprinoides* and *Elope indicus* (leptocephalus and later stages), *Gerres filamentosus, Scatophgus argus, Sillago sihamat Hemirhamphus gaimardi* and *Ambassis* sp. are given in the paper.

In the *early post-larval stage,* most of the above fishes possess the capacity for quick adaptation to wide and sudden fluctuations in salinity and other environmental conditions; but advanced stages (2 to 3 inches long) of at least *Megalops* and *Elops* are found to be more susceptible to changes, resulting in considerable mortality. The knowledge that these fish seeds at this early stage can withstand even direct transference from brackish to freshwater has a vital bearing on the possibilities of their successful culture in freshwater. Their small size and absence of mortality during acclimatisation would enable transport of large numbers at relatively low cost.

26. Factory effluents from the Mettur Chemical and Industrial Corporation Ltd., Mettur Dam, and their effects on the fisheries of the river, Cauvery.

S. V. GANAPATI and K. H. ALIKUNHI, Madras.

Since the construction of the Mettur Dam it has become an annual feature that a series of connected rock pools are formed in the bed of the Ellis surplus course when the water ceases surpulssing. Thousands of carps and catfish are then entrapped in these pools. The factory effluents from the Mettur Chemical and Industrial Corporation are at present discharged into these pools. These effluents consist of an excessive amount of dissolved and insoluble solids, chlorides and free chlorine, and are highly alkaline due to the caustic lime used in the manufacture of bleaching powder. Since the pools are stagnant, the addition of these toxic wastes pollutes the waters and invariably results in large-scale mortality of the trapped fish during the summer months. With the Ellis surplus functioning, the pools overflow and the pollutional wastes are considerably diluted and rendered harmless to fish life.

With a view to prevent this annual mortality and the consequent depletion of the fish stock in the conserved area, the conditions of the pools were investigated at different seasons during the last 3 years. While biotal life was not altogether absent in the pools even under extreme summer conditions, those receiving direct discharge of the wastes and the neighbouring ones with their offensive odour were totally unfit for fish life of any kind.

Chemical treatment of the effluents and dilution before letting into the pools proved ineffective and uneconomical. Since excessive dilution appears to be the easiest method to render the effluents innocuous, diverting the same to the main river to a spot close to the tail race of the Mettur Power House is suggested.

27. Hydrobiological notes of the river Cauvery at selected fishing centres in the Madras Presidency.

S. V. GANAPATI and K. H. ALIKUNHI, Madras.

The river Cauvery, with its major tributaries like the Moyar and the Bhavani, yields about two-thirds of the annual revenue derived from inland fishery sources in the Madras Presidency. Important fishery centres along the Cauvery system like Theppakadu and Poongar along the Moyar; Mettupalayam, Poongar, Satyamangalam and Bhavani along the Bhavani; and Hogainkal, Mettur, Bhavani, Upper Anicut, Grand Anicut and Lower Anicut along the main river, were visited on one or more occasions during different seasons, and the conditions existing there were studied. The qualitative and quantitative nature of fish congregations in these centres and the stage of maturity of the gonads have been correlated with the physico-chemical and other ecological data.

28. Conditions of existence in some fish farms and ponds in the Madras Presidency.

S. V. GANAPATI and K. H. ALIKUNHI, Madras.

Hydrobiological and ichthyological studies of the fish farms and ponds under the control of the Madras Fisheries Department were made during the last 3 years (1945-48). Different types of waters, wherein particular species of fish appeared to grow more satisfactorily than others, were encountered during these observations. An attempt has been made in the present paper to classify these waters on the basis of certain physico-chemical and biological traits such as colour, hydrogen-ion concentration and phytological constituents. The species of fish best suited for the different types of waters have also been indicated.

29. The food of some post-larval Clupeoids.

D. V. BAL and S. V. BAPAT, Bombay.

The stomach contents of the post-larvae of the following species were examined:- *Megalops cyprinoides, Chatoessus nasus, Engraulis hamiltoni, E. purava, E. commersonianus, E. tri, E. dussumieri, E. kammalensis, Coilia dussumieri, Clupea lile, C. brachysoma, C. kunzei, C. toli, Pellona brachysoma, P. elongata, P. motius* and *P. filigera*. All except *Clupea toli*, were found to be carnivorous. *C. toli* appears to be omnivorous, as an appreciable quantity of diatoms was in the stomach. *Chatoessus nasus* and *Clupea kunzei*, which were mainly obtained from Mahim Creek, contained a large percentage of sand and mud, thereby indicating bottom-feeding habits. The early stages of most of these species feed mainly on Copepods, whereas the more advanced stages take to larval prawns, Amphipods, Gammarus, etc. The stomatchs of *Chatoessus nasus* and *Clupea lile* are muscular, as in the Mugils.

30. The food-habits of some young Sciaenids.

D. V. BAL and S. V. BAPAT, Bombay.

The food-habits of the post-larval stages of 4 species, namely *Sciaena miles, S. albida, S. glauca* and *S. semiluctosa* and of *Otolithus argenteus* were studied. Generally, the young forms are voracious feeders, as the stomachs of the majority of the specimens were gorged with food. All the species appear to be carnivorous as no trace of herbivorous food like diatoms or algal matter was found. The earlier stages, measuring upto 75 mm. long, feed mostly on prawn larvae while the more advanced stages take larger and coarser food like crabs, Stomatopod larvae and food fish; the percentage of fish food is higher in the older stages.

31. Inland fisheries of Kodinar.

T. V. R. Pillay and J. S. Shaw, Okha and Kodinar.

Investigations conducted during 1947-48 showed that creeks and backwaters form the most important type of inland waters and fishing is done here by the Kharvas and Kolis of Vanakbara, Kotda and Velan with cast nets, drag nets, gill nets and traps. 17 species of fish were collected. The Chikkhli and Velan backwaters are ideal sites for the opening of fish farms and oyster parks. A farm will soon be started at Velan for the culture of oysters, mullets, pomfrets and the Indian Salmon. Experiments were successfully conducted in acclimatization of the fry of *Stromateus cinereus*, *S. sinensis* and *Parastromateus niger* to brackish and fresh water conditions.

Of the five small rivers flowing through Kodinar, the Shinghoda is the most important. 8 species of fish were found in this river in its upper reaches, and 15 from the estuary. The fry of *Labeo boggut* are available in the river after the monsoon, and they can be utilised for pond culture. The young ones of *Stromateus cinereus* are seen in the estuary from December to May, and this will serve as a source of seed supply for the proposed Velan Farm. The presence of young ones of *Hilsa ilisha* in the estuary tends to prove that they ascend the river and breed in the estuary.

The ponds in the *taluka* are mostly seasonal; the perennial ones are the temple tanks where the religious susceptibilities of the villagers prevent any fishing. Anti-malarial fish culture is the only activity which is likely to receive public co-operation. Exotic fish will have to be introduced for the purpose as local larvivores are not efficient enough.

32. On the nutrition of the young stages of certain estuarine fishes of Madras.

P. I. Chacko, *Madras.*

The salient features of the food and feeding habits of the fry and fingerlings of 14 species of estuarine fishes of Madras are: (1) *Elops saurus*: Feeds on crustacea, like *Acetes*, young *Penaeus*, *Rhopalophthalmus*, *Lucifer* and *Mysis*; and on young *Stolephorus* and *Gobius*. (2) *Megalops cyprinoides*: Is mainly a plankton feeder on micro-crustaceans and diatoms. (3) *Chanos chanos*: Feeds on planktonic organisms like microcrustacea, diatoms, larval bivalves and gastropods, and also on filamentous algae. (4) *Lates calcarifer*: Is markedly piscivorous and feeds on *Stolephorus*, *Spratelloides*, *Gobius* and *Oryzias*; also on shrimps and young prawns. (5) *Lutjanus lineolatus*: Its food habits are similar to that of *Lates*. (6) *Ambassis commersoni*: Is a pure plankton feeder. (7) *Therapon jarbua*: Is omnivorous; feeds on Polychaetes, shrimps, young prawns, filamentous algae and insect larvae. (8) *Diagramma crassispinum*: Its food consists of shrimps, young prawns, filamentous algae and larval worms. (9) *Gerres filamentosus*: Fragments of molluscan shells and Polychaete worms form its chief diet. (10) *Scatophagus argus*: Algal matter, microcrustacea and diatoms are eaten. (11) *Sillago sihama*: Is omnivorous; consumes

Polychaetes, Amphipods, shrimps, young prawns, and algal filaments. (1) & (13) *Mugil dussumieria* and *M. ocur*: Are mainly plankton feeders. (14) *Etroplus suratensis*: Feeds mainly on algal filaments and diatoms; microcrustacea and Protozoa are also consumed.

33. Bionomics of the Indian Paradise Fish, *Macropodus cupanus* in the waters of Madras.

P. I. Chacko, Madras.

Macropolus cupanus (*Cuv.* & *Val.*) grows to a maximum length of 90 mm. in the Madras waters. Its food consists of desmids and diatoms (35%), filamentous algae (20%), microcrustacea (20%), protozoa (5%), insect larvae (15%), and sand & debris (5%). It attains maturity when 8 months old when it is 40 mm. long. It breeds throughout the year, with maxima in April and September. During the breeding period the male is brightly coloured, and has elongated dorsal and anal fins. 200 to 300 eggs are laid after courtship lasting 30 minutes, in a bubble-nest amidst floating or emergent vegetation. The fertilised egg is 1.0—1.25 mm. in diameter. Embryonic development lasts nearly 3 days. The hatchling is 2.5 mm. long, and remains attached to vegetation; it becomes free-swimming on the third day. Adult characters are attained within 4 weeks, till which period the male takes care of the brood. The species is pugnacious and attacks and kills minnows, but do not feed on them. Under laboratory conditions it consumes 480—620 mosquito larve. It is suitable for anti-mosquitoicidal purpose in paddy fields, ditches and swamps. It is hardy, is capable of withstanding climatic and environmental changes, and can be successfully transported to distant places.

34. Bionomics of *Lepidocephalichthys thermalis* (Cuv. & Val.) in the Madras waters.

P. I. Chacko, Madras.

This fish grows to 70 mm. and feeds on: (1) filamentous algae such as *Chaetophora, Cladophora, Microspora, Nostoc, Oedogonium, Oscillatoria, Spirogyra* and *Ulothrix* (70%); (2) desmids and diatoms like *Amphora, Closterium, Cosmarium, Cyclotella, Diatoma, Desmidium, Fragilaria, Gyrosigma, Navicula, Nitzschia, Pinnularia, Stauroneis, Suriella, Synedra* and *Tabellaria* (20%); and (3) Protozoa, microcrustacea, rotifers and sand-grains (10%). It attains maturity when 50 mm. long. The female carries 200-300 eggs which are 0.7—0.8 mm. in diameter. The inner pectoral ray of the male is developed as a flat spine. During the breeding season (October—January) the fish swarms in shallow areas covered thickly with *Spirogyra* and other filamentous algae. Spawning occurs during the early hours of the day. Fertilised eggs are pinkish, 0.9—1.1 mm. in diameter, and remain attached to the algae. Embryonic development is rapid, and hatching takes place on the third day. The larva, which is 3 mm. long grows rapidly and attains adult features within a month. The swarming habit during the breeding period are taken advantage of by the rural people for collection of the fish for consumption.

35. Migratory Governments of fishes of the Coleroon.

P. I. Chacko, Madras.

The lower reaches of the Coleroon river is subject to tidal influence to a distance of 25 miles from the sea, and is frequented by 49 species of saltwater fishes. Of these, *Mugil boornensis, M. olivaceus, Lates calcarifer, Polynemus tetradactylus* and *Therapon jarbua* ascent further into freshwater area up to the Lower Anicut (33 miles), *Hilsa ilisha* and *Etroplus suratensis* up to the Upper Anicut (110 miles), and *Megalops* *cyprinoides* up to the Mettur Dam (250 miles). The important freshwater species which show local movements within the river are *Catla catla, Labeo fimbriatus, Cirrhina cirrhosa, Wallagonia attu, Callichrous bimaculatus, Pangasius pangasius, Mystus aor, M. seenghala* and *Notopterus notopterus*. The existing and proposed conservancy operations, including the provision of a fish-ladder in the Lower Anicut are discussed.

36. Observation on fishes of the Vellar Estuary, Porto Novo.

P. I. Chacko, Madras.

The fishery of the estuary which is subject to tidal influence throughout the year, is mainly contributed by 100 species of fish, 5 of Crustacea and 5 of Mollusca. The occurrence of marine forms like *Carcharias melanopterus, Zygaena malleus, Trygon, uarnak, Osteogeniosus militaris, Sardinella brachysoma, Pellona brachysoma, Chatoessus chacunda, Engraulis malabaricus, Belone strongylura, Hemirhamphus xanthopterus, Holocentrum rubrum, Caranx hippos, C. sansun* and *Chorinemus moadetta*, and of freshwater species like *Wallagonia attu, Callichrous bimaculatus. Pangasius pangasius, Silundia sykesii, Mystus aor, M. seenghala, Labeo fimbriatus, L. kontius, Cirrhina cirrhosa, Catla catla, Danio aequipinnatus, Rasbora daniconius* and *Chela sardinella* are of special interest.

A census of the fisherfolk, crafts and tackle and the existing marketing arrangements, the availability of facilities for estuarine farming and seed collection are indicated. The suitability of the area for the establishment of an estuarine biological station is discussed.

37. Fisheries of the Upper Godavari, with special reference to the Ramapadasagar Project.

P. I. Chacko, Madras.

78 species of fishes have been recorded from the upper Godavari. The similarity of this fish fauna to that of the Krishna and the Tungabhadra is explained by the conditions of their sources and country (the Deccan) through which they flow. The spawning grounds of the carps, particularly the mahseer, and of the Siluroids are indicated. The shad, *Hilsa ilisha,* runs up to the Dummagudem Anicut, a distance of 210 miles from the sea. The Ramapadasagar Project, which is about to be executed across the river, consists of a dam one mile long and 200 feet above the river bed. The reservoir would cover 527 sq. miles. The fishery problems arising out of this project by obstruction of free passage of fish, moderation of flow of water, and the formation of the reservoir and canal systems are discussed. A fishery station, with a programme for conservancy, cultural, developmental and harvesting operations is being established. The provision of a fish ladder of suitable gradient is also being considered.

38. The Krishna river and its Fishes.

P. I. Chacko, Madras.

The Krishna river has a course of 250 miles in the Madras Presidency. The first 150 miles run through deep gorges and forest areas. 87 species of fish occur in this stretch, and contribute to a fishery similar to that in the Tungabhadra river. The lower reaches of the river are subject to tidal influence up to 35 miles from the Bay of Bengal. 65 marine and estuarine species of fish similar to those in the tidal zone of the Godavari, have been recorded from here. 8 species of Crustacea also contribute to the commercial fisheries of the estuary. *Hilsa ilisha, Lates calcarifer, Sciaena belangeri* and *Mugil* *olivaceus* ascend the river to a distance of 30 miles beyond the tidal zone, the first species for spawning and the others for feeding. 27 spawning and nursery areas of carps and other freshwater species are located for collection and distribution of fish-seed to other inland waters. Statistics of 714,750 fish-seed so far collected and stocked are given. The presence of fingerlings of saltwater species of the genera *Mugil, Megalops, Lates, Polynemus* and *Lutjanus* in the estuary and their suitability for acclimatisation and rearing in freshwaters of the Godavari and Krishna districts are discussed. The need for more stringent measures for conservancy of spawners and young ones, and for the introduction of the 'Pearl Spot,' *Etroplus suratensis,* in the estuary are indicated. The occurrence of *Cirrhina mrigala* in this river is detected for the first time.

39. Fish and fisheries of the Muthuppet Saline Swamp, Tanjore District.

P. I. Chacko, Madras.

The Muthuppet Swamp, 200 sq. miles in area, has direct connection with the Palk Strait along a narrow seaboard of 30 miles. 5 small rivers empty into it. 89 species of fishes and 8 of Crustacea contacea contribute to a perennial fishery here. Mullets and *Etroplus suratensis* breed within its limits. *Lates calcarifer* and *Polynemus tetradactylus* breed in the inshore area of the adjoining sea from October to December, and their young ones migrate into the swamp for shelter, feeding and growth. Fingerlings of *Chanos chanos* and *Megalops cyprinoides* also occur in the swamp. A fish farm and nursery have recently been established in a nearby area to exploit these fish seed sources for the stocking of inland waters.

40. Preliminary report on the fishery resources of the Bhavani river in relation to the Lower Bhavani Project.

P. I. Chacko and P. Dinamani, Madras.

The Bhavani river flowing through the Coimbatore district, is subject to both the monsoons. It is an important river-stretch, containing 75 species of fish, most of which find spawning and nursing facilities in it. *Barbus tor, B. hexagonolepis, B. carnaticus, Cirrhina cirrhosa, Labeo fimbriatus, L. ariza, L. boga, L. kontius, Wallagonia attu, Macrones aor, M. seenghala, Pangasius pangasius, Silundia* and *Notopterus* sp. are the chief species spawning in the river. A masonry dam, 8 furlongs long and 125 feet high, is to be constructed across the river near the Pungar village, to form a reservoir about 32 sq. miles in area. Considerable hydrographical and biological changes are expected both up and down stream in the dam, adversely affecting the important fluviale fishery. A programme of fishery management, consisting of conservation, cultural operations, judicious exploitation of the reservoir, provision of fish way, and research and investigation is detailed.

41. An ecological reconnaisance of the fishes of the Red Hills Lake.

P. I. Chacko and P. Dinamani, Madras.

The Red Hills Lake, about 8 sq. miles in area, situated on the outskirts of Madras City affords facilities for fish production. The physical, chemical and biological conditions of the lake are detailed. 42 organisms occur in its plankton. 40 species of fishes are listed. *Etroplus suratensis,* which was stocked by the Fisheries Department, has bred and multiplied, and contributed to a good portion of the existing lake fishery. *Megalops cyprinoides* occurs in good numbers during the rainy season. The fish fauna is otherwise poor in quality, and lacks in major carps and siluroids. A programme of stocking with species like *Catla, Mrigal, Gourami, Barbus dubius, Chanos,* etc., conservation, exploitation and marketing is outlined.

42. Notes on *Hilsa kanagurta* (Bleeker) and *Hilsa toli* (Cuv. & Val.)

P. I. CHACKO and B. KRISHNAMURTHI, Madras.

The external characters distinguishing *Hilsa kanagurta* and *Hilsa toli* are tabulated. The former lives in estuaries and inshore sea, whereas the latter is a purely marine form. Both are surface swimmers and feeders; the former feeds on zooplankton and phytoplankton in equal proportions, whereas the latter feeds on zooplankton only. They prefer to feed during the early hours of the day. *Hilsa kanagurta* abstains from feeding during the spawning season (August to November). *H. toli* breeds from October to January and feeds during the period. Maturity is attained when 5 to 6 inches in length in the case of *H. kanagurta,* and 12 to 13 inches in *H. toli.* The young ones of the former associate with *Chatoessus chacunda,* and the adults of the latter with the mackerel.

43. Hermaphroditism in the Indian Shad, *Hilsa ilisha* (Ham.)

P. I. CHACKO and B. KRISHNAMURTHI, Madras.

A specimen of *Hilsa ilisha* 17.5 in. long, 5 in. high and weighing 3 lbs. had in the anterior one-third of both of its gonads the structure of testis and the posterior two-third, the structure of ovary. It was obtained from the Godavari, delta.

44. Feeding and breeding habits of the common carps of south India.

P. I. CHACKO and G. K. KURIYAN, Madras.

Catla sp. is a surface and midwater feeder, its diet mostly consisting of vegetable matter, diatoms and desmids and microcrustacea. *Labeo fimbriatus* feeds largely on diatoms and algal matter; and *L. calbasu* on algal matter and microcrustacea. *Cirrhina cirrhosa* is mainly a plankton feeder, whereas *C. reba* feeds on algae and diatoms. *Barbus (Tor) khudree* is mostly piscivorous. Insects and insect larvae predominate in the diet of *Barbus hexagonolepis* and *B. carnaticus.* The breeding period commences by the end of May with the commencement of the south-west monsoon, and extends to the end of October. Shallow river margins and adjoining areas containing emergent vegetation or submerged boulders, with moderate flow of water, form favourable spawning grounds. The maximum spawning takes place in the first half of the season during night and the early hours of the morning. A lunar peridicity is also observed.

45. Food and feeding-habits of certain fishes of the Tungabhadra River.

P. I. CHACKO and M. J. MATHEWS, Madras.

(1) *Rohtee ogilbii* feeds mainly on plankton such as *Anabaena, Microspora, Nostoc, Cosmarium, Cymbella, Fragrlaria, Gonatozgon, Navicula, Nitzschia* and *Synedra.* (2) *Macrones vittatus* consumes insect larvae, *Gerris, Hydrometra* and microcrustaceans. (3) *Glossogobius giuris* is a predator and feeds on small species of fish such as *Chela phulo, Aplocheilus blochii* and *Barbus ticto,* and also on larval insects. (4) *Notopterus notopterus* is carnivorous and consumes fishes like *Aplocheilus blochii, Oryzias melastigam* and carp fry, and also shrimps and aquatic insects. (5) *Callichrous macrophthalmus* feeds mainly on insects, shrimps, crabs and carp minnows. (6) *Callichrous pabo* feeds on shrimps, cyprids and daphnids. (7) *Bagarius bagarius* is markedly piscivorosu and eats *Chela argentea, Chela phulo, Amblypharyngodon mola,* and fry of *Labeo fimbriatus* and *Catla.* (8) *Puntius kolus* consumes filamentous algae, diatoms, desmids and microcrustaceans.

46. Preliminary report on the fishery biology of the Tungabhadra Project, Hospet.

P. I. CHACKO and M. J. MATHEWS, Madras.

The dam under construction across the Tungabhadra is 8,200 ft. long and 150 ft. high at the deepest section. Considerable changes are expected in the fish life of the river when the project is completed. The meteorologcal and hydrographical conditions of the area are recorded. 66 organisms have been identified from the plankton of the river. 85 species of fish have also been recorded from this region. *Callichrous pabo* (Ham.) has been recorded here for the first time; this record is of zoogeographical interest. *Osphromenus gorami, Etroplus suratensis, E. maculatus, Gambusia affinis* and *Lebistes reticulatus* were introduced into the river in 1947 as a preliminary to development of the fluviale fisheries. The collection of fishlings from 20 spawning and nursery areas in the river for stocking lentic waters is indicated.

47. Food and feeding habits of *Labeo boggut* (Sykes).

P. I. CHACKO and (Miss) SHARADA SUBRAMANIAN, Madras.

The food consists of (1) Desmidiaceae (*Closterium, Cosmarium, Desmidium, Euastrum* and *Pleurotaenium*) (5%); (2) *Bacillariaceae,* (*Achnanthidium, Coccaeis, Cyclotella, Cymbella, Eunotia, Fragilaria, Frustulia, Gomphonema, Gyrosigma, Mastogloia, Melosira, Navicula, Nitzschia, Stauroneis, Synedra* and *Tabellaria*) (15%); (3) Chlorococales, (*Ankistrodesmus, Oocystis, Pediastrum* and *Scenedesmus* (5%); (4) Oedogonales (*Oedogonium*) (5%); (5) Conjugates (*Spirogyra, Microspora* and *Mougeotia*) (15%); (6) Cyanophyceae (*Anabaena, Aphanocapsa, Coelosphaerium, Cladophora, Lyngbia, Nostoc, Oscillatoria* and *Spirulina*) (35%); and (7) mnd. sand & scum (20%). The fish mainly browses on algal mater and bottom debris. Animal matter is totally absent in its diet. Though growing to a size of 8 inches only, the easy availability of its young stages in large numbers in the Tungabhadra and Krishna drainages from July to October makes it suitable for stocking rural waters.

48. Fisheries of the Adyar River.

P. I. CHACKO and (Miss) SHARADA SUBBRAMANIAN, Madras.

This Small river, 25 miles long, flowing along the southern border of the Madras City is very favourable for fishery improvement. Being subject to tidal influence for about 6 months in the year, there is a predominant marine element in the fauna of the river. The plankton consists of 52 species of diatoms, 5 of desmids, 7 of Chlorococcales, 13 of Cyanophyceae, 10 of protozoa, 11 of crustacea and 1 of mollusca. The existing fishery if poor except when the bar is open. 82 species of fishes have been recorded from the entire river stretch. The occurrence of seed of saltwater species acclimatisable to freshwater adds to the importance of the fishery. Statistics of collcetion and stocking operations are given. The food and feeding habits of ten species are described; and the larvicidal and cyclopscidal tendencies of *Rasbora daniconius, Etroplus maculatus, Ambassis nama* and *Barbus sophore* are indicated. The need for the introduction of larger carps like *Catla,* and regulation of exploitation of the fisheries in order to cater to the needs of the increasing population of the City are emphasised.

49. The morphological and histological variations of the lung in anakes.

(Miss) M. R. VARDE, Bombay.

It has been found that the lungs in snakes vary considerably. The histological study of the lungs reveals four main types. (i) The simplest type is met with in

Enhydrina valakadien in which, except for the greatly enlarged development of the investment of the muscular and connective tissue, the lung-tructure resembles that of the frog, and the alveolar elaboration is poor. (*ii*) In *Python molurus, Ptyas mucosus, Geradia prevostiana* and *Cerberus rhyncops* there is a folding of the partitions and a greater development of the alveoli. (iii) In *Naia tripudians* and *Echis carinata* the partitions are more folded and the cavities thus formed are divided into innumerable alveoli. The lateral chambers are also more numerous. (iv) In *Hydrophis cyanocinctus* the extent of the pulmonary tissue is reduced, as there are no marked subdivisions of the lateral chambers.

From the standpoint of morphology, three distinct lines of evolution are seen: (a) The simplest shows the retention of more or less the original dimensions and relations of the lung, as in *Python* in which two lungs are present. (b) The second line shows a posterior extension of the single lung present so as to form a capacious reservoir for storing up air. (iii) Its highest expression is met with in aquatic snakes such as those of the genera *Hydrophis, Cerberus,. Gerardia* and *Enhydrina* and in the terrestrial genus Echis. Here an anterior extension of the lung takes place, incorporating the trachea in it.

50. The extent of development of the Premaxilla in snakes.

(Miss) M. R. Varde, Bombay.

There is considerable variation in the shape and extent of the development of the premaxilla of snakes. In some cases this variation is met with amongst the different genera of a family. The primitive form of the premaxilla among reptiles appears to be T-shaped, with an anterior broad head bearing two short lateral limbs and a conspicuously long posterior process. The premaxilla of the lizards is generally of this shape. In the primitive families of snakes such as the Boidae and the Colubridae, this fundamental shape remains unaltered. In the genus *Acrocordus* (Family Colubridae), however, the premaxilla is reduced and appears to be made up of two symmetrical pieces, one on either side. Whether this paired condition is more primitive than the triradiate single one, or is secondary, remains undecided. Form the fact that the premaxilla is double in *Sphenodon,* there is some ground for supposing that the *Acrochordus* premaxilla exhibits the ancestral condition. An intermediate condition is found in the Viperidae. In some members of the Hydrophiidae, (*e.g. Hydrophis*) the median limb of the premaxilla is reduced to a vestige, while in others (*e.g. Microcephalophis*) it assumes a more or less triradiate condition.

51. Observations on the structure of the heart of the snaks *Typhlops* sp.

Hanmesh V. Kashyap, Dharwar.

With a view to establish the nature of the interventricular septum in the heart of snakes, the study of the structure of the heart of *Typhlops* sp. was undertaken. The main features of the heart are as follows:—(1) The sinu-auricular aperture is obliquely transverse and its caudal valve is continued into the right auricle as a ridge. (2) Each auriculo-ventricular apeture is guarded by a single valve not fastened to the wall of the ventricle by chordae tendinae. (3) In fresh hearts the venous and arterial halves of the ventricle are indicated externally by difference in colour. (4) The interventricular septum is incomplete and is the only septum present in the ventricle, indicating that the primary function is to divide the ventricular cavity into venous and arterial halves. (5) There is present in the wall of the ventricle a cartilaginous rod which is a feature peculiar to snakes, and is recorded here for the first time.

SECTION OF ANTHROPOLOGY & ARCHAEOLOGY

PRESIDENT: PROF. NIRMAL KUMAR, M.Sc.

1. Co-ordination of Anthropological Field-work in India.

T. C DAS, Calcutta.

The necessity of recording the culture of the backward groups for national reconstruction. Absence of any organisation for disemination of information regarding investigations undertaken by persons and institutions in different parts of the country. The necessity of co-ordination among anthropological field-investigators. Suggestions for setting up an organisation for this purpose.

2. Personality and Culture.

NABENDU DUTTA-MAJUMDER, Calcutta

The growth of *Personality and Culture,* a new field of Anthropology, is based on the recognition of the existence of an intimate interrelationship between the cultural background and the character of individuals living within that culture. Here, the problem of great scientific importance is, not just to know that different cultures produce different personalities, but to ascertain how and why different personalities are produced in different cultures The solution of this problem depends on a dynamic, genetic study of the child as it grows up in its socio-cultural environment.

Students of *Personality and Culture* have already developed such concepts as *communal* or *modal* and *idiosyncretic* personalities,-concepts which are extremely useful for a proper understanding of the behaviour of adult members of a socio-cultural group. Again, the dependence of our psychological reactions on the cultural background has been indicated clearly by the conclusion, reached by Margaret Mead in her genetic study of children in Samoa, that emotional storms and stresses found in adolescents in the United States are not due to the fact of adolescence, as was thought to be the case, but are culturally determined. For, in Samoan culture adolescents pass over this period without emotional difficulties.

3. A brief study of the cultural developments in India.

M. N. BASU, Calcutta

In this short paper the writer discusses the meaning of culture introduction, the religion and ceremonies associated with it, racial contacts, study in transmutation, Bengal's culture, Sakti cult changed, and culture of different areas.

4. Korku physical type.

K. P. CHATTOPADHYAY, Calcutta.

The writer measured fifty Korkus of Melghat forest during his visits in 1938 and 1940 The measurements and indices are noted and the physical type described. There are no earlier measurements of Korkus reported.

5. The Kabui.

TARAK CHANDRA RAYCHAUDHURI, Calcutta.

The paper is based on somatomeric measurements on 100 subjects. They are short (72%) mesocephalic (62%) with a good percent (25%) of dolichocephals. The altitudinal index is variable-51% hypsicephalic and 36% orthocephalic. There is a greater variation in facial index-24% euryprosopic, 38% mesoprosopic, and 26% leptoprosopic. The nose is generally leptorrhine (64%) but as many as 34% are mesorrhine. The orbitonasal index leads us to suspect a blend of two elements—there being 35% platyopic and 47% pro-opic.

6. Possibility of a racial significance by colour preference.

M. N. BASU, Calcutta.

Feeling-tone of the Parois, Bunas, Koms, Noluas and the Bengali College Students are discussed in this paper and the writer tries to draw some conclusions from them.

7. The Somatometry of the Parois of Jessore.

M. N. BASU, Calcutta.

400 adult male subjects were measured by the writer with the help of Martin's anthropometric set including the two callipers and the results are analysed in the light of modern physical anthropology.

8. Anthropometric study on the Santal of the Santal Parganas.

P. C. BISWAS, Delhi.

The Somatometrical measurements of one hundred male Santals of the Santal Parganas mostly from Damin Area (Dumka and Godda) were taken by me to find out the physical types of the Santal. I have arrived at the following conclusion from the above measurements.

The Santals are short statured; long-headed and flat-nosed people. Their skin colour is dark-brown; hair colour, black; and hair form, wavy; body hair is scanty. Eye colour is dark-brown to black.

9. A study of the Physical Characters of the Kandhs.

G. S. RAY, Calcutta.

The Kandhs are quite well-known people in the anthropological field all over the world. They formerly used to practise human sacrifice inorder to have a bounty crop. There is some literature concerning their social and religious institutions and economic persuits; but no one has yet studied them intensively either from the cultural or from the physical standpoints.

The present paper deals with the study of their physical characters. The study was carried out on 100 individuals from nearby village of Phulbani, the headquarter, of Khondmals, in Orissa.

From the study it is found that the majority of the Kandhs are bright tawny in complexion with wavy hair. They are between short and below medium in stature. The mean stature is 159.96 cm. They are mainly dolicocephalic (mean C.I.73.57) mesorrhine (mean N.I. 77.13) people.

10. Growth and Development of Bengalee women students.

A. N. CHATTERJI, Calcutta.

The study is based on the measurements taken of 2093 woman students from Calcutta schools and Colleges. The averages together with the standard errors of height and weight, vital capacity and strength of grip (right & left) and ponderal index for age groups 10 to 20, are given. The averages are compared with the corresponding figures for Bengalee boys. The period of rapid growth is shown to be years 10 to 13. Between the ages 14 and 16 the rate of growth is slowed down and after the 16th year the increase in height is negligible, but the weight and vital capacity increase slowly till the 20th year. A comparison is made with similar figures for the English, Japanese and Philippino students.

11. Some celts and chisels from West Bengal.

D. SEN, Calcutta.

A number of ground celts and chisels has been found near Bamal on the river Kasai in the Jhargram subdivision of the Midnapur district in West Bengal. The implements have been described and the surface geology of the place discussed in the paper.

12. A Report on a further collection of Palaeolithic implements from the lateritic sites in Mayurbhanj.

D. SEN, Calcutta.

In course of a field-work in March 1948, a collection of stone implements was made from the Kuliana and Kalabaria lateritic sites in Mayurbhanj. Work was more concentrated at Kalabaria where two trial trenches were opened and a number of tools were found *in-situ*. The rest of the tools found in the lateritic pits and incrusted with lateritic nodules evidently also come from the laterites. The main tool-families provisionally identified in this collection are the hand-axes, cleavers, choppers, scrapers, borers, discs etc, besides some simple flakes. The leading tool-family is that of the hand-axe represented by a variety of types. Here we have predominatly a core-tool culture somewhat recalling the Abbevillian-acheulian. Along side the core-tools, the occurence of a few flake tools and simple flakes which recall the early clactonian type is also significant.

The tools are found in the Secondary low-level laterites generally upto a depth of 6 feet from the ground surface. They seem however to concentrate here between 1'6" and 4'. No tool has yet been found in the boulder conglomerates or any other deposits than the detrital laterites. The exact geological dating of the laterites is here a problem.

13. The Megalithic problem of Chingleput.

V. D. KRISHNASWAMI and K. V. SOUNDARA, RAJAN, Madras.

This paper brings out the nature and importance of the particular problem connected with the sepulchral megalithic structures of Chingleput District, for which the explorations conducted by the Department of Archaeology in the last four seasons, in this region have prepared the ground. It succinctly describes the mode of dispersal of these monuments in relation to geographical factors.

Certain sites like Pandur and Nanmangalam lying respectively in the northern lateritic and the southern granitic region of this district, reveal only one type of monuments prevalent namely the Cairn Circles. In the majority of cases, we find in both regions a promiscuous mingling of both the two types of monuments namely the dolmenoid-cists and the Cairn Circles belonging to this region. We find also in a few of these mixed sites sometimes, a segregation of the two types of megaliths, as in Sirudavur, Panaiyadivakkam etc.

In the past based on sporadic observation of a few sites it had been surmised that such a separation was due to sexual classification on the one hand and a status-grouping attempted by the megalithic folk, on the other. Division on a Pallava-Chola basis was also propounded for the monuments in certain sites near Pallavaram and Chingleput.

The paper does not only show the distinct individuality in the Chingleput district of the dolmenoid-cists enclosing terracotta legged sarcophagi and their characteristic mutual association with the Cairn Circles enclosing pyriform urn burials; it also presents how the non-megalithic urn burial culture of Tinnevelly in the tip of the Peninsula has:

(1) effected a probable fusion in this region with, in the course of its northward migration the megalithic (sarcophagus) culture of Chingleput which does not go south of South Arcot and,

(2) absorbed in its turn megalithic appendages, resulting in the Cairn Circles of the region surviving along side of the dolmenoid-cist in this district.

Discussing the peripheral influences at work in this transformation, the paper deals also with the existing evidences for dating the megalithic and other sepulchral monuments of South India, which eventually will help to date the Chingleput megaliths.

14. Preservation of fabrics in Museum.

M. N. Basu, Calcutta.

25 museum fabrics made of cotton were treated by the writer in the Museum method laboratory of the Department of Anthropology, Calcutta University and the results discussed.

15. A Santal bird net.

K. P. Chattopadhyay, Calcutta.

The writer describes a hand-operated semi-automatic net used by Santals in Mayurbhanj to trap birds. The net is like an elongated cylinder in outline and kept in position by pegs. When closed by a pull of a string by the operator from a distance, two sticks hold up two sides of the trap which shut and form a cage (Illustrated).

16. Turtle Lore.

S. T. Moses, Baroda.

Definitions—Egglaying of turtles—Biomythic significance of the turtle—Tortoise and consmogony of the Hindus—Tortoise and Sathapatha Brahmahas—Taittiriya Aranyaka—Puranas—The esoteric and evolutionary interpretation of the Avatars—Gond belief about 'Genesis'—Cheros' idea of creation—American Indian beliefs—Huge sizes and longevity of these creatures are apparently the causes of these beliefs—Liberation of turtles caught—Ease in capturing Hawksbill turtles when feeding on Physalia—Turtle catching on land by 'turning it over'—Turtle deities at Sri Kurmam, Tellicherry and Nerenika—Offerrings of wooden tortoises as cure for diseases—rituals where tortoises live and images figure—Kachuga lineate because of stripes is called the mendicant tortoise—Shape of tortoise followed for seating planks for meals, marriages etc.—Yagna Kunds—Silver tortoise and foundation stone laying ceremony—Tortoise feeding at Siddhanath, Agra, Puri etc.—Mudturtles and pisciculture—Mudturtles and public health —Turtle eating—cases of fatality—turtle flesh taboo in Laccadives etc.—Tortoise flesh an invigourator and courage giver—Turtle eggs a delicacy—Turtle oil and beliefs about uses—Beliefes about tortoises and house building—Tortoises and totems—Tortoise stories about perseverance, friendship and evils of talkativeness—Tortoise and self discipline—Tortoises in proverbs and riddles.

17. Khasi land ownership and Sale.

K. P. CHATTOPADHYAY, Calcutta.

The writer briefly describes changes in land tenure of privately owned land and the usual procedure of land sale among Khasis aswellas how boundaries are demarcated (Illustrated.)

18. A short note on Khasi bone disposal.

K. P. CHATTOPADHYAY, Calcutta.

The writer furnishes certain details regarding the disposal of the bones of a cremated person, when the full formal ritual is not performed at the burning of the dead body. Now-a-days deviations from the full rite is usual and the writer notes the procedure followed in such case. (Illustrated).

19. The Concept of After-life among the Adibasis of India.

T. C. DAS, Calcutta.

Concept of the soul among the Adibasis of India. The 'other world', its situation and nature. How far life in this world affects life in the other. The concepts of sin and retribution among the Adibasis. Influence of Hinduism. Effects of these ideals on the practical life of the Adibasis.

20. Blood and the Primitive.

(Mrs.) HILDA RAJ,

General attitude of the primitive to blood, and beliefs arising therefrom.
Animal blood, human blood.
Blood of man, of woman. Blood of kings and priests.
'Blood is life'. Transmission of life strength and courage through blood.
Blood, a vehicle of contagion. Transmission of impurity, weakness, cowardice-source of danger.
Blood as a bond of brotherhood and love.
Practices-blood used for purification-in fertility rites-in medicine-for magic-for contracts.
The ceremonial pouring on of blood.
The ceremonial drinking of blood.
Taboos attached to blood.
Symbolism.
Interpretation.

21. Suggestions for improving human relations in Indian Industries.

J. K. BOSE, Calcutta.

In this paper a conciliation machinery has been suggested to develop good relations in the Indian Industries.

22. Metopism in Bengali Skull.

R. N. BASU, Calcutta.

Observations and meansurements of 200 Skulls, were made and the data collected.

36TH INDIAN SCIENCE CONGRESS: ALLAHABAD: 1949

ABSTRACTS

(Advance Issue)

SECTION OF MEDICAL & VETERINARY SCIENCES

President : Dr. M. B. Soparkar, M.D., B. Hy., F.N.I.

MEDICINE AND PUBLIC HEALTH

1. On the Seasonal Variation of some common skin diseases as seen in the Out-patient Department of the School of Tropical Medicine, Calcutta.

L. M. Ghosh, Calcutta.

This is an observation on the seasonal variation of six common skin diseases namely—Allergic dermatitis, Impetigo contagiosa, Lichen planus, Psoriasis, Ringworm and Scabies as seen in the out-patient department of the School of Tropical Medicine, Calcutta.

The skin out-patient department of the School having an attendance of 10,000 or more new skin cases every year may rightly claim to give an average good figure for analysis. It attracts patients both from the city and the surrounding suburbs so that the figures may be taken to represent the incidence of the diseases in this part of the country. The analysis has been based on the observation from the attendance of the patients in four years. The result may be briefly stated as follows :—

There is distinct significance in the seasonal variations of three diseases namely Psoriasis, Ringworm and Scabies. The incidence of psoriasis is higher in winter (from November to February) and in the dry summer months from March to June. The incidence of ringworm is higher in the humid months of July to October and scabies occurs more in the winter months from November to January.

2. Fluorine—Its effect on Enamel of Teeth and on Prevention of Dental Caries.

M. B. Daver, Hyderabad—Deccan.

Chronic Fluorine intoxication is wide-spread in the Nizam's Dominion.

Fluorine content of water less than one part per million appears to be innocuous. Above this threshold, it produces various manifestations of Fluorine intoxication.

The various manifestations of enamel of teeth, vary according to the concentration of fluorine.

Fluorine concentration not much above its threshold has preventive action on caries of teeth ; provided the child had come to live in fluorine area, before the age of six.

Incidence of dental carries and number of cavities per child was less in those who consume water containing higher fluorine concentration.

Mottling of teeth and incidence of caries were more amongst those who were poorly fed and mal-nourished.

Figures are given showing the percentage of freedom of caries, number of cavities per child and average caries figure for various comparable groups examined in India.

3. Viability of Cholera Vibrios in Chlorinated and Non-chlorinated Waters and Alcohols.

G. Panja, Calcutta.

In tap waters of Calcutta (pH 8.3 to 8.4), vibrios are viable upto 20 hours and rarely upto 48 hours. In deep tubewell water (pH 7.7) viability is seen upto 96 hours as a rule but in shallow tube well waters (pH 7.9) vibrios are killed in 4 hours whereas in unfiltered Hooghly river water, the organisms are viable for much longer time, uptill 48 hours and nonviable after 96 hours.

In chlorinated tap water, 2 per mille, vibrios are viable for 15 seconds only and become non-viable in 30 seconds. In strength of chlorine 1 per mille, viability persists for 1 minute and in strengths from 0.2 to 0.1 per mille, viability is maintained for one to two hours. It is therefore desirable that our drinking water should be chlorinated at least 1 per mille.

In alcohols, 3 to 5 per cent, vibrios are viable for 15 minutes but non-viable in 30 minutes. In gin diluted 1 in 2, vibrios are killed in one minute but when diluted 1 in 4, the organisms are viable for 4 minutes and in beer diluted 1 in 3 the vibrios survive for one minute only and are killed in 2 minutes. This shows that a drink of alcohol after an infected meal may eliminate the vibrios.

All the viability experiments with the above fluids were conducted at room temperature.

4. A case of a Cholera-Carrier.

G. Panja, Calcutta.

Very few cases of true cholera carriers are on record.

An eosinophilic lung case, gives no history of past cholera nor any bowel trouble but gives history of contact only one year ago. Cholera vibrios were isolated from the stool on 2 consecutive days and none were found in the next two days' examination. Blood showed agglutinin to the titre of 1 in 160. It is presumed that the patient was harbouring the bacilli in gall bladder and there was periodic discharge of vibrios from the gall bladder into the gut.

5. Viability of the Cholera Vibrio in the Body of the Common House Fly.

M. B. Soparkar, Bombay.

With the object of studying the role of the common house fly (Musca domestica) in the spread of cholera experiments were undertaken to determine the length of time during which the cholera vibrio remains viable in the body of the fly after its ingestion.

Laboratory bred flies fed with a mixture of sterilised milk and a suspension of young culture of cholera (Inaba strain) were dissected at intervals varying from 2 hours to nine days and their gut contents examined culturally for presence of cholera vibrios.

Of over 1050 flies fed in a series of 22 experiments 522 were examined. Of the 45 flies examined within 2 to 8 hours after feeding nearly 50 per cent (22) showed viable cholera vibrios. Beyond this interval, however, upto nine days none of the remaining 477 flies examined showed a positive result except in only one instance out of 101 flies examined 24 hours after feeding.

In another series of 29 experiments to study transmissibility dejecta of 150 flies were examined at varying intervals. Cultural examination of their dejecta deposited at intervals from 1 to 12 hours after infective feed showed viable cholera vibrios in 32 out of 90 flies examined. In the remaining 60 flies further examination after 12 hours upto six days showed no cholera vibrios except again in one instance—24 hours after feeding (1 out of 12).

The results indicate that the common house fly remains infective for only a few hours after feeding on matter containing cholera vibrios.

6. On a Bactericidal Principle for Cholera Vibrios found in the Body of the Common House Fly (Musca Domestica).

M. B. Soparkar, Bombay.

In experiments reported in another paper it was shown that the cholera vibrios when ingested by the common house fly at a single feed were either rapidly excreted or were destroyed in the gut of the fly.

Experiments were made to examine if the gut of the fly had a destructive effect upon the cholera vibrio.

An extract of the dissected out crop and intestine or even of the whole abdomen of the fly made with tyrode solution when mixed with a suspension of cholera vibrios was found to destroy them and render the mixture sterile suggesting the presence in the body of the fly of a bactericidal principle. Study of some of the properties of this principle brought out the following among other points.

That the principle acted quantitatively and had also a time factor.

That it could withstand a temperature of 115°C. under pressure.

That it was not heat coagulable.

That it was soluble in water but insoluble in acetone and ether.

That it was not precipited by phosphotungstic acid.

That it was dializable.

That it had a selective action on vibrios—both agglutinable cholera vibrios as well as non-agglutinable water vibrios but had not the same bactericidal action on other organisms tested e.g. B. typhosus, B. dysenteriae, Flexner and Shiga, B. coli and Staphylococci.

The action of the bactericidal principle is demonstrated by the fact that when 0.5 c.c. of the dialisate of the fly extract was mixed with a suspension of five million cholera vibrios and incubated it was capable of destroying them and rendering the mixture sterile in fifteen minutes while the non-dializable portion of the extract when similarly treated showed profuse growth of cholera vibrios even after 48 hours of contact.

Much further work will be necessary to determine the precise nature of this bactericidal principle.

7. Summary of Experimental Work on the Derivatives of Diamino-Diphenyl Sulphone in the Treatment of Leprosy.

R. G. Cochrane, Chingleput, Madras.

Much work has been done on the Sulphones within recent years. It is now possible more accurately to assess the value of these remedies. Recent work indicates that the Sulphone drugs act largely by virtue of the fact that they are concentrated in the tissues, particularly the skin. In order to compare the efficacy of the sulphones with Hydnocarpus Oil a standard must be set up. It is suggested that workers conducting therapeutic trials by the Sulphone derivatives should adopt a method of recording which will enable them compare the relative efficacy of these drugs with the Hydnocarpus (Chaulmoogra) remedies or any other remedy which may show promising results. The method of estimating a bacteriologic index for this purpose is described.

The individual Sulphones now in use are detailed and their methods of administration and relative efficacy compared. A plea is made to exercise great caution in claiming success for this treatment, although admittedly the sulphone remedies appear superior to any other treatment in advanced lepromatous leprosy. It is suggested that until a suitable Sulphone is discovered which can be injected by subcutaneous or intramuscular injection, these remedies cannot be used at present for mass treatment.

8. Significant factors in the Epidemiology of Leprosy with particular reference to South Indian Conditions.

R. G. Cochrane, Chingleput, Madras.

The epidemiology of leprosy is discussed in the light of the recent International Conference at Havana and particular attention is drawn to its report on Epidemiology & Control. The early contributions of Muir and Santra are acknowledged as pioneer work. It is stressed that survey work unaccompanied by active control measures, or which does not add to the sum total of our knowledge of the epidemiology of the disease, is of little value.

The epidemiological work over the last ten years in Madras is outlined and certain salient features emphasised. The need for repeated surveys over a period of years in areas where no measures to control leprosy have been organised is stressed. For only thus will it be possible to study the conditions in a community which influence the control of the disease. It is believed that proper correlations of epidemiologic findings is the only sure way of developing a sound preventive policy. Too often measures which are taken to prevent leprosy ignore these facts and therefore much money is wasted and discouragement follows. The prevention of leprosy should be based on a careful study of all epidemiologic data which generally speaking are not difficult to secure.

9. Demonstration of Preerythrocytic Stages of a Malaria Parasite in the Himalayan Flying Squirrel, *Fetaurista* inornatus (Geoff).

H. N. Ray, Mukteswar.

From time to time since 1937 nine out of every ten specimens of Himalayan Flying squirrel were found to harbour a malaria parasite in their blood. Smears and sections of liver of the positive cases showed schizogony in (1) groups of small cysts besides (2) merocyst information as described for P. Kochi (=Hepatocystis Kochi) of monkeys by Garnham (1947). In two cases the spleen was involved while in one of these two the lumg also showed groups of small cysts. Microscopical preparations showing these various stages along with photomicrographs are presented for demonstration.

10. Intramuscular Paludrine.

R. N. Chaudhuri *and* N. K. Chakravarty,
Calcutta.

Paludrine lactate has been tried in thirteen patients suffering from malaria by intramuscular route in single doses varying from 100 to 300 mgm. The injections were somewhat painful but the pain and local tenderness usually disappeared within 3 days of the injections. On post mortem examination in a fatal case no sign of necrosis was noticed at the site of injection. Excepting one case of pernicious malaria with very heavy *falciparum* infection who died within 36 hours of admission, the temperature was normal and the peripheral blood was cleared of asexual parasites by the end of the third day of treatment in 66 per cent and 91 per cent respectively. In this series 3 *falciparum* cases relapsed after three weeks and one *vivax* case after six weeks.

11. Plasma Protein Changes in Tropical Eosinophilia.

R. N. Chaudhuri *and* H. Chakravarti, Calcutta.

The paper presents the results of a study of plasma proteins changes in a series of 37 patients suffering from *tropical eosinophilia* in the hospital attached to the School of Tropical Medicine. The diagnosis was based on the presence of pulmonary symptoms with an absolute eosinophil count in the peripheral blood of at least 2,000/cu. mm. The controls were selected for comparison from patients suffering from bronchial athma without eosinophilia. The average normal was determined among a series of 75 individuals representing the community comparable in status and dietary habits with the subjects of this investigation.

The plasma proteins were estimated by copper sulphate method and biuret method. The results of the analysis are given in the following table.

TABLE I.

		Total Protein	Albumin	Globulin	A/G X : 1
		Gramme per cent			
A. Tropical Eosinophilia (37 cases).	Range	9.6—6.5	4.6—3.0	5.8—2.0	0.6—1.2
	Mean	7.13	3.43	3.88	0.91
	S. D.±	0.73	0.48	0.65	0.19
B. Bronchial Asthma (8 cases).	Range	7.5—6.8	4.8—3.9	3.2—2.4	2.0—1.3
	Mean	7.0	4.3	2.7	1.6
	S. D.±	0.43	0.35	0.28	0.27
C. Normal (75 individuals.)	Range	8.0—6.2	5.5—3.9	3.3—2.0	2.4—1.5
	Mean	7.1	4-5	2.6	1.8
	S. D.±	0.73	0.37	0.29	0.23

The results indicate that, in general, there is frequent rise in globulin fraction which is occasionally so marked as to raise the total protein above normal. The albumin fraction appears normal or slightly depressed and the albumin globulin ratio is lowered due to the rise in globulin. In the uncomplicated cases of bronchial asthma hardly any change in plasma protein is noticed.

Estimation of plasma protein was repeated in 20 cases of tropical eosinophilia after the treatment with arsenical injections, the results being as follows as compared with the values obtained before the treatment was instituted.

TABLE II.

	Total Protein	Albumin	Globulin	A/G X : 1
	Gramme per cent			
Before Treatment	7.19±0.54	3.38±0.47	3.78±0.68	0.93±0.22
After Treatment	6.69±0.59	3.65±0.45	3.04±0.48	1.22±0.26

It is apparent from the above table that the plasma protein pattern tends to be normal after the arsenical treatment.

Conclusion.—Hyperglobulinaemia with occasional rise in the total plasma proteins, the albumin fraction being normal or slightly reduced has been observed in patients suffering from tropical eosinophilia. This is very suggestive of a chronic infective process. These changes may also be helpful in the differential diagnosis of the doubtful cases of tropical eosinophilia from the uncomplicated cases of bronchial asthma.

12. Koilonychia (Spoon Nail) in Anaemia.

C. R. Das Gupta *and* J. B. Chatterjea Calcutta.

It is the condition in which the nail plate instead of being convex, is concave.

In mild cases the nail is simply flattened, but in the fully developed form it is concave in the centre and the edges are raised and project so much that the free margins and the sides are lifted off the nail bed. Some degree of longitudinal ridging may also be present. All the nails may be affected but the condition is most marked on the thumbs and fore fingers. It is generally found associated with hypo-chromic anaemia but has also been reported in cases of thyrotoxicosis and has also been seen in people working with sulphuric acid, Benzene, etc.

In a very large number of cases of anaemia, over 2,000 seen critically for over 10 years at the Anaemic Department of the School of Tropical Medicine, Calcutta, koilonychia has been noted so far in twelve cases only. In all these cases, the anaemia was hypochromic in type, and not a single case was seen in association with macrocytic anaemias. Of the twelve cases, eight were males and four females, one of which, a case of idiopathic hypochromic anaemia in an European female, aged 45 years, was reported in the I. M. G., April 1940. In the remaining eleven cases, the ages were 12, 15, 18, 30, 31, 36, 38 and 60 in the males and 17, 30 and 35 in the females. Five of the cases gave a history of piles for 2 years or more and one female case gave a history of 13 pregnancies in 16 years. Fractional gastric analysis was done in five cases and free hydrochloric acid was present in all the cases and sternal puncture was done in six of the cases in all of whom the marrow was active and normoblastic in reaction. Mild H.W. infection was found to be present in 6 of the cases, many of whom gave history of bleeding piles as well, and it is presumed that anaemia in these cases was not due to infection with hookworm alone. On the other hand, we have never found koilonychia in any case of hookworm anaemia—due to heavy infection with hookworm. All the cases in our series improved with iron, but the condition generally persists even the blood picture returns to the normal.

Summary.—From critical observations in over 2,000 cases of anaemia, we are of opinion that though the presence of well defined koilonychia is a sure diagnostic feature of hypochromic anaemia, it is not a characteristic feature of hookworm anaemia, which is essentially hypochromic in type. The condition is, however, more commonly found in hypochromic anaemias due to chronic blood loss as in bleeding piles.

MICROBIOLOGY, PATHOLOGY AND PARASITOLOGY.

13. Inhibitive Action of Sodium Chloride Concentration on Non-pathogens in Foeces.

P. V. Gharpure, Bombay.

This is a continuation of the study on preservation of foeces for bacteriological study. The aim being the working out of an ideal concentration method for the Dysentery, Typhoid and Cholera group of organisms. By the use of the neutral glycerine saline (composition described by the author—I. M. G. Vol. LXXX, No. 12, p. 618-19, December 1945) and varying the NaCl concentration, colony counts are done. The optimum time and NaCl concentration are worked out.

14. Pyruvate Dismutation by Sensitive and Insenstitive Pathogens in relation to Penicillin Bacteriostasis.

Mariam George, P. A. Kurup *and* K. M. Pandalai, Bangalore.

In attempts made to elucidate the mode of action of antibiotic agents like Penicillin, we found that Magnesium ions have the interesting property of bringing down the minimum inhibitory concentration of penicillin in the case of gram-negative pathogens like *Esch. coli*. *B. dysenteriae*, etc. Since Magnesium ions play important roles as coenzyme in *in-vivo* phosphorylations it was thought that in the sensitive pathogens, phosphorylation reactions occur in a perfect manner while this is not so in the insensitive pathogens. Accordingly the dismutation of pyruvate by the sensitive organisms like *S. aureus* on the one hand and insensitive organisms like *Esch. coli* on the other was studied in the presence of added thiamine, magnesium ions, inorganic phophate, etc. The results showed that while added thiamine quickly disappeared in the case of *S. aureus*, there was no change in the case of *Esch. coli* When however magnesium ions were added, the added thiamine disappeared appreciably. By gas measurements and inhibition studies by the addition of small concentrations of agents like sodium fluoride, hydrogen cyanide, etc., to the cultures it was confirmed that reaction pathways could be altered in the case of *Esch. coli* and the organisms made to become more allied to the sensitive ones, thus requiring only lower minimum inhibitory concentrations of penicillin. It is therefore concluded from these studies that,

1. Sensitivity or otherwise of a particular pathogen to penicillin appears among other things to be tied up with metabolic reaction mechanisms adopted by the pathogens.

2. The magnesium ions appear to render insensitive organisms like *Esch. coli*, *B. dysenteriae*, etc., became more sensitive to penicillin by altering the reaction pathways in the stage where pyruvic acid is oxidised probably by rendering the phosphorylation of thiamine more efficient to produce cocarboxylase required for oxidation.

These results emphasise the possibility of rendering penicillin resistant organisms more sensitive to penicillin by appropriate treatment, an aspect of great theoretical and clinical importance.

15. Sensitisation of Penicillin Resistant Organisms by Mixed Culturing with Insensitive Organisms.

Mariam George *and* K. M. Pandalai, Bangalore.

We have shown that difference in the susceptibility of certain pathogens to Penicillin is associated with differences in the metabolic reaction pathways, adopted by the respective pathogens, as well as the presence or absence of certain catalytic complex systems in them. It should then be possible that pathogens short of or devoid of such catalytic mechanisms, if provided from without, could become more allied in nature to the Penicillin sensitive organisms and consequently become more susceptible to Penicillin.

That organisms do get sensitised according to this principle was revealed from experiments made by mixed culturing of a sensitive and insensitive pathogen, isolating them and studying their minimum inbibitory requirements of Penicillin. Thus untreated *E. coli* requires 10 units of Penicillin for complete inhibition while *E. coli* cultured together with a sensitive strain of *S. aureus* for 16 hours isolated and examined required only 1.0 unit per c.c. In a similar test *B. typhosum*, requiring 12 units per c.c. in the untreated state, required only 4 units per c.c. Indeed the minimum inhibitory concentration of Penicillin in the case of *S. aureus* itself came down to 0.03 unit per c.c. from 0.1 unit per c.c. when it was grown in association with *E. coli*, and to 0.04 unit when grown in association with *B. typhosum*. An association of half an hour at 37°C is enough to effect a transference of sensitivity. The aquired sensitivity lasts for fairly long intervals. It was however observed that when *B. dysenteriae* was grown in association with *S. aureas*, the former became more resistant to penicillin.

This shows that while there are a number of yet unknown factors in reversing drug resistance, the sensitivity of pathogen to a drug like penicillin is a very labile factor of the bacterial cell, which is essentially a chemical one. Organisms do adjust themselves in their metabolic reactions by adapative changes, when grown in association, such that it is possible to render insensitive pathogens more sensitive to a drug as a result of the functioning of unknown symbiotic agencies. The wide possibility of these findings in reversing drug resistance in resistant pathogens and their clinical application are discussed.

16. Study of a Quantitative Test for Urobilinogen in Urine.

P. V. Gharpure, Bombay.

Detection of urobilinogen was recommended for the diagnosis of malaria. The method recommended has been studied in detail and a simplified technique is described. The temperature, time factor, quantity of the urine and the reagents, effects of the size of tubes, the diameter and height are some of the factors studied.

The method described by the author is efficient and less expensive.

17. Diagnosis of Human Plague by Sero-agglutination Test.

G. Panja *and* S. K. Gupta, Calcutta.

During the last epidemic of plague in Calcutta, which started in April 1948, 169 cases were bacteriologically investigated. 17 cases were bacteriologically positive for plague bacilli and in 15 cases, slide agglutination test of the patients' sera with four live strains of *Past, pestis* was satisfactorily positive. Tube agglutination test was also positive but was not so satisfactory for recording as the former. In 2 cases only the test was negative and the serum was collected very early in these cases, i.e., on the 3rd or 4th day of disease and one patient died on the 3rd day of disease. In the positive cases, agglutinin was detectable generally on the 7th day of disease, earliest being the 4th day and it persisted uptill 1 month (examined).

Eleven suspected cases were bacteriologically negative both by bubo puncture and by blood culture and in all these cases agglutination test was positive in the majority of cases from the 4th to 6th day of disease. Without the help of the agglutination test, it was not possible to diagnose these cases bacteriologically. These were simply suspected cases.

In the rest of the suspected cases, cultural as well as the serological tests were both negative.

In all the bacteriologically and serologically positive cases, agglutination test with *Past. pseudotuberculosis* and *Past septica* was negative. Sera from 75 normal cases examined did not show any agglutinin for *Past. pestis*. All our 4 antigens for agglutination test were agglutinable with specific plague immune rabbit sera (American).

18. Studies on the Oxygen Requirements of Nematodes.

P. V. Gharpure, Bombay.

Two nematodes are studied—

(1) Ascaris lumbricoides (of man).

(2) Strongyloides (of dog).

These can survive outside the host for varying periods, the former less and the latter longer.

By excluding oxygen the viability has been studied.

Suggestion is put forth that intestinal parasites are partial anaerobes.

19. Acute Dysentric Conditions due to Schistosome Infection in Cattle.

S. R. Rao, Bombay.

Schistosomes as a cause of dysentry in cattle was for the first time noted in this country. The organism that was responsible for this condition is identified as *Schistosoma-bovis* whose occurance in India gave rise to much controvercy. The author pleades for a thorough investigation of this problem throughout the Indian Dominion so that suitable treatment could be given in time. It is felt this condition whether due to *Schistosoma-bovis* or any other sp. is more widespread than is believed to be. Photographs of the eggs of *Schistosoma-bovis* together with those of S. indicum and S. haematobium are given for comparison.

ANTIBIOTICS

20. The Antibiotic Principle from the Roots of Aristolochia Indica.

P. A. Kurup, Mariam George *and* K. M. Pandalai, Bangalore.

During the course of a detailed search of the more important Indian medicinal plants for their antibiotic contents, it was found out that the roots of *Aristolochia Indica* gave an alcoholic extract which was highly antibacterial to test organisms like *Staph. aureus* and *E. coli.* An attempt was then made to concentrate the active principle and to determine its antibacterial spectrum.

500 grams of the fresh roots of the plant wree chopped into small pieces and extracted overnight with absolute alcohol (4 c.c. per gram). The extract was concentrated and diluted with three volumes of water. It was then acidified with 2% Hydrochloric acid and was extracted with ether. The aqueous portion was separated and meutralised with Sodium bicarbonate and again extracted with ether. The ether extract was washed with water until free from alkali, and the ether removed at low temperature in vacuum. 65 m. gms. of the crude product was obtained as a pale yellow solid. It inhibits the growth of *Staph-aureus, E. coli* and *E. Typhosa* at a dilution of 1/50,000, while that of *B. dysenteriae, Para-B,* and *Para-C* at a dilution of 1/100,000. Attempts to purify the product further and to study its toxicity, blood level etc. are in progress.

21. Search for Antibacterials *in Phanarogams.*

G. C. Mitra, K. R. Chandran *and* N. K. S. Rao, Calcutta.

The accordance of antibacterial principles with certain higher plants remains an established fact and several such substances antagonistic to bacteria, diverse in nature have already been isolated. In this paper a systematic investigation—for a search for 'antibacterials in species of phanerogams selected mainly on the basis of Ayurvedic Materia Medica has been carried out and the results of plants so far studied have been noted, especially detailed investigations are being continued in the case of promising ones.

Fresh plant materials, locally collected were washed and macerated with purified sand into a pulp with just the requisite quantity of distilled water, strained through muslin and finally filtered free of chlorophyll. The pH of these extracts were adjusted to 7.4—7.6.

The plant extracts were tested by our modified double plate method against nine pathogenic species of bacteria both gram +ve and gram—ve types including *Bacillus subtilis* (viz., *Staphylococcus aureus, S. albus* Woods, *Escherichia coli communis, Salmonella schottmulleri, Eberthella typhosa, Shigela dysenteriae var. Shiga, Vibrio cholerae* Inaba and *Klebsiella pneumoniae*). Fifty-five plants belonging to 31 families have so far been studied and it is being noted that *Paasiflora foetida* Linn., *Clematis cadmia* Ham., *C. gouriana* Roxb., *Clycosmis pentaphylla* Corr., *Cinnamomum zeylanicum* Bryn., *Calotropis procera* Br., *Tagates patula* Linn., *Lippia nodiflora* Rich., *Euphorbia pilulifera* Linn., *Hiptage madablota* Gaertn., and *Croton sparsiflora* Morong. have all shown complete inhibition of all or most of the above mentioned bacteria and the rest have shown either partial or no inhibition of them.

22. Antibiotic Activity as shown by a Highly Amylolytic Strain of Bacillus Subtilis.

Bhagwan S. Lulla, Bangalore.

Bacillus subtilis when grown on wheat bran produces antibiotic activity which is maximum in 24 hours old culture, correspondingly the amylase activity during this period is very low. When the incubation period is further extended, the antibiotic activity steadily decreases and the amylase activity at the same time increases.

B. subtilis is non-lipolytic in its action, when it is grown on wheat bran as a whole and defatted wheat bran respectively the concentration of amylase and antibiotic secretions in both cases remain nearly the same. This suggests that the antibiotic activity is not due to the hydrolytic products of wheat bran fat as stated by earlier workers.

The relationship between the amylase and antibiotic production by the genious *B. subtilis* when grown on wheat bran has been discussed.

PHARMACOLOGY AND THERAPEUTICS.

23. Studies on the Toxicity of certain Formo-Sulpha Compounds.

A. N. Bose, Calcutta.

Sulphonamide derivatives are not so effective in the treatment of Asiatic Cholera. Some reports are available regarding the beneficial effects of sulpha-guanidine in such cases Recently, Bhatnagar *et al* have recorded successful results on the treatment of Asiatic Cholera cases by a formaldehyde derivative of sulphathiazole, termed 6257 (Nature, **161,** 395, 1948). In order to study the characteristic of other similar compounds, formol-derivatives of sulphacetamide and sulphanilyl benzamide have been prepared in this laboratory and subjected to pharmacological studies. It is being found that sulphacetamideforma compound is more toxic than the corresponding Sulphanilyl Benzamide compound, though it does not affect the rate of normal growth of mice. The drug was fed 1 mg./gm. orally for 10 days as well as by drug-diet (2%) for 15 days). P-methylol-amino-sulphanilyl benzamide given with drug diet (2% for 15 days is found to be devoid of any chronic toxicity, as shown by the normal growth curve of mice, and absence of any mortality, when observed for a period of 5 weeks.

24. Studies on Arsenoxide Derivatives—Part I.

A. N. Bose, Calcutta.

p-carbamidophenylarsonic acid (Carbarsone) is a well-tolerated amoebicidal with wide use. Though effective, it has not served as yet a permanent curative effect in cases of cronic amoebic dysentry Accordingly. the co-rresponding arsenious derivative has been prepared in this laboratory and subjected to pharmacological tests. It is being found that p-carbamido phenyl arsenious acid. (CP.A.) possess more toxic properties than carbarsone. Orally fed in 4 mg. per gm. dose to mice for 7 days, it causes 60% mortality in 4 weeks. In drug-diet also of (0.5 to 1%) it causes great retardation of growth and late mortality. Carbarsone in 2% drug diet causes neither any mortality nor any effect on the rate of normal growth of immature mice, when compared with control animals. Post mortem findings of mice died from C.P.A. reveals fatty infiltration of liver, enlargement of kindneys, and congestion of spleen.

25. Studies on Sulphonamides and Analogous Compounds : Part IV—Role of Unsaturation on the Antibacterial Activity.

N. K. S. Rao, K. R. Chandran *and* U. P. Basu, Calcutta.

The activity of the Schiff's bases prepared from Sulfathiazole, p-amino phenyl methyl sulphone, 5-amino salicylic acid and p-amino benzoic acid by reacting with cinnamic aldehyde against *E. typhosa* and *V. Cholerae* indicates that the unsaturation in a compound may play a role in imparting and/or enhancing the bactericidal property in a compound which may itself be an inhibitor, or promoter for the growth of the organism in culture medium. As these cinnamic aldehyde derivatives are not completely hydrolysed by 0.4 N hydrochloric acid within a period of 3—4 hours and as some of these compounds are very active against *E. typhosa,* their further study would be of considerable significance.

26. A Preliminary Note on the Action of *Pterocarpus Marsupium* on Blood Sugar.

K. N. Ojha, Paramjit R. Pabrai *and* K. Venkatachalam, Cuttack.

Pterocarpus Marsupium Roxb. (N. O. Leguminosae) has been known to possess anti-diabetic properties ; drinking water from vessels made of the wood has been reported to be used by diabetic patients.

A study has been made on the action of the drug on blood sugar to ascertain if it has got any antidiabetic effect.

A 1 in 10 aqueous extract was used. After taking the blood fasting of rabbits and diabetics, one ounce of the above extract was administered orally. Blood was taken every hour for five hours and blood sugar was determined of each specimen and of the five-hour pooled sample. A continuous fall in blood sugar was observed, the maximum percentage blood sugar reduction being in the second hour after administration of the drug in rabbits as well as in diabetics.

Urine examination of the same diabetics with Benedict's Reagent showed continuous and rapid disappearance of sugar in hourly specimens. Last sample showed absence of sugar.

No toxic symptoms were observed. No alteration in the concentration of glucose was observed in *vitro* tests.

As the drug has been tried only in a few cases no final conclusions can be drawn in respect of the mode of action, the optimum initial and repeater dosages and identification of the antidiabetic principle. Work in these directions is in progress.

27. On the Efficacy of Tobacco Leaf in the Treatment of Sarcoptic Mange.

Paramjit R. Pabrai, P. S. Kupuswamy, K. Venkatachalam
and K. N. Ojha—Cuttack.

Sarcoptic mange was observed in rabbits kept for experimental purposes in the Department of Pharmacology and Pathology here. Usual advice given in such cases is to destroy the individual rabbit to stop the spreading of the infection. Tobacco is said to possess antiseptic properties when used locally. With the idea that it may be effective a chance was taken with an alcoholic extract (1 in 10) to treat this condition.

Sarcoptic mange was diagnosed microscopically in the suffering rabbits, the lesions were painted with the medicament twice a week. Remarkable progress was observed on the very first application. There was a gradual falling down of the crust from all the lesions, leaving healthier skin underneath. Almost simultaneously with the falling of the crust hair growth made itself manifest. On an average four to five applications were sufficient for complete recovery. All cases without exception proved amenable to this treatment. Local applications do not produce any toxic symptoms except mild irritation for a short while.

The drug may also be of grrat therapeutic value in the treatment of alopecic conditions due to parasitic infections.

28. On the Efficacy of Sex Hormones in the Treatment of Peptic Ulcers

K. N. Ojha *and* K. Venkatachalam, Cuttack.

Since 75 to 80% of the cases of peptic ulcers occur in men and their complications are observed 10 to 15 times more in men than in women, it was thought worthwhile to try the effects of female sex hormones on the symptoms of a few cases of gastric and duodenal ulcers in men. The results being encouraging, they are submitted with the idea that others may subject this line of treatment to more trials and if their observations are so encouraging as they have been with us and warrant the use of the hormones in the treatment of these ulcerated conditions of stomach, a great boon will be conferred on the suffering humanity.

In our experiments, stilboesterol was used in 10 mgm. doses daily for 8 to 10 days or till the patient complained of tender and enlarged nipples. A few days after stopping the treatment the symptoms get less and gradually disappear. In some cases abatement of symptoms occured from the second day of the beginning of the treatment. The symptoms generally disappear in about 2 to 4 weeks time.

Since cases treated have been few in number and have not been under observation for long it is not possible at this stage to assert as to when the symptoms will reappear, if at all, and would necessitate repetition of the treatment.

29. Studies on the Chemotherapy of Vibrio Cholerae.

N. K. S. Rao *and* U. P. Basu, Calcutta.

The findings of Poth & Ross (*J. Lab. Clin. Med.* **29**, 785, 1944) on the activity of pthalyl Sulphathiazole in bacillary dysentery, and of Bhatnagar *et al* (*Nature*, **161**, 395, 1948) on the chemotherapeutic value of "6257"—a condensation product of sulphathiazole and formalin, tend to show that for the manifestation of effective threapeutic activity the Sulpha-compound must be ingested in such a way that it may be present at the focus of infection in its active anion form with free amino grouping for engaging the acid group of the bacterial enzyme protein (*cf.* Klotz J. M., *Science*, **98**, 60, 1943 ; Davis & Wood, *Proc. Soc. Expt. Biol.* Med., **51**, 283, 1942). With a view to explore the possibilities of encountering more potent derivatives, various well-known Sulphonamides have been reacted with formalin and the resulting 4-hydroxymethyl-amino-benzene-Sulphonamide derivatives have been studied *in vitro* for their activity against *V. cholerae*. The speciality of the compound derived from Sulphanilyl-benzamide has been discussed.

36TH INDIAN SCIENCE CONGRESS, ALLAHABAD 1949.

SECTION OF AGRICULTURE

PRESIDENT : DR. R. S. VASUDEVA, Ph.D., D.Sc., D.I.C.

Abstracts

1. Control of Agrotis Pest by Cultural Operations.

A. C. SEN, Sabour, Bihar.

Agrotis ypsilon Rott. in its caterpillar stage has been responsible for causing destruction to about 20 to 47% of the total Rabi crops produced in Bihar. Our laboratory trials had shown that the caterpillars attack the gram and wheat seedlings from the shooting up of the sprouts to 22 days'. old plants and plants of 3 weeks' standing can considerably resist the attack and do not suffer much.

It has been found that the maximum damage is caused by the second brood of the pest and this happens in the first fortnight of November. The only inexpensive devise to tide over this critical period of attack is to resort to the inexpensive cultural methods of control, that is, either by advancing the sowing time or by delaying it, so as to get a clear margin of 3 weeks' time.

In 1947, large scale field trials were laid out at the common habitat of this place, in the low lying areas in Bhagalpur district, at the two adjoining villages Dhanaura and Amdhar, with a view to find out the effects of early and of late sowing on the incidence of the pest under natural conditions. The areas were thoroughly surveyed before sowing operations, had identical conditions and plot history and had been kept under regular observations till harvest. 4 such plots of land, of ⅛ acre area under each and at a distance of 600 to 800 yards away from one another, were selected for the purpose. In the first village, sowing was done on 18th, 22nd. and 26th. October, 1947 and in the other series, in village Amdhar, on 12th, 16th and 20th November, 1947. Sowing was done in the control plots, at both localities, on 4th November, 1947 which was the usual date of sowing in these localities.

Results—In the early sowing plots, the incidence of attack in all the plots were nil and in the Control plot it was 15% and a loss of 30% of the crop yield. In the late sowing series, the incidence of pest attacks was more marked in the plots wherein sowing was done in the first part of November that is, from 4th to 12th November, 1947 resulting in 20% infestations on the control plots and a loss in yield by 47% and thereafter gradually declining with late sowing of the crop, that is, an infestation of 8% on the plot where sowing was done on 12.11.47 and nil on the other plots where sowing was done on 16th and 20th November, 1947.

2. Albinism in Sugarcane.

GYANENDRA VARMA, Shahjahanpur.

A certain number (1% to 2%) of albino plants and tillers appear in Sugarcane fields in July and August, which die out by the end of monsoon. These plants are usually regarded as genetic sports, arising from bud mutation. Data are presented to show that certain cultural treatments, viz. delay in planting, irrigation after sowing, applications of nitrogenous and phosphatic manures affect the incidence of albino plants in a given plant population, whereas the time of application of manures, and the application of K_2O have no effect on their occurrence. There are slight indications that applications of Mg, Mn and Cu are beneficial in this respect. Whereas the above observations suggest that albinism is not a purely genetic phenomenon, its being partly so is not altogether ruled out.

3. Seed Treatment of Rice.

K. Ramiah *and* S. Y. Padmanabhan, Cuttack.

An experiment was conducted to test the effect of seed protectants on the germination of rice and to test how long treated seeds of rice would retain their viability unimpaired in storage. Ten varieties of paddy were treated with 4 protectants, namely Agrosan G.N., Arsan, Phygon, and Spergon, and at 3 levels of concentration, namely, 1/250, 1/500 and 1/750 of the weight of protectant to the weight of grains. Two series of controls were maintained: One in which the seeds were treated with the diluent used in the chemicals *viz.* talc, and the second without any treatment whatsoever. The seeds were treated in the last week of January and stored in cloth bags. Eight germination records were taken at 30 day intervals from February '48 until Sept., '48.

The results show that the germination is not adversely affected by long storage after the treatment. While the fall in viability of the grain was very rapid in the controls after the 6th month and beyond, such fall was not noticeable in many of the treatments, notably in the Phygon and Spergon series; the loss of viability was low or negligible. By the time the viability was completely lost in most varieties by the eight month, the treated seeds gave germination of 65 to 85%.

It is known that several of the early rice varieties lose their viability in storage after a few months, particularly when the storage period happens to synchronise with rainy weather conditions. Where such storage is inevitable the use of the chemical protectants appears to be encouraging. The investigation is being continued.

4. A New Method of Cane Plantation in the Water-Logged Area of the Rajshahi District during Monsoon.

T. C. N. Singh, Annamalainagar.

It has been established that early plantation of canes during August-September-October, ensures better performance than the November-December plantation. But uncertain conditions of monsoon have been a limiting factor. The plantation is, therefore, resorted to by seedlings raised in nursery beds. This naturally has been a very tedious method involving a very high cost of cultivation.

Under the new scheme the sets are directly planted parietally on one side of the trench and they are left bare un-covered with earth; the final operation of covering them with earth is deferred to a stage till the germination is complete.

In the case of Co 421 and Co 527 acclimatised under the ecological conditions of East Bengal, it has been found that if the planted sets remain submerged under water for even more than two weeks, the viability of the buds is not impaired at all, rather they keep growing even under these abnormal conditions and after the recession of water, the germination completes up very quickly. In each case under observation, it was found that the germination percentage was not less than 92%. Soon after that as soon as the dry conditions intervene, the sets are covered. The subsequent growth and performance have been found to be very satisfactory, both from the view point of tonnage and sucrose content.

5. On the So-called "Deterioration" in Sugarcane Varieties.

N. L. Dutt *and* K. S. Subba Rao, Coimbatore.

Complaints are occasionally received from cane growers as also from certain farms that the sugarcane varieties in their respective tracts are showing deterioration.

The sugarcane variety Co. 419 which has given such good results both in the cultivators' fields and the factory farms in the Bombay Presidency was reported to have "deteriorated." This so-called "deteriorated" material of Co. 419 was obtained from the Bombay Presidency and was grown along with the healthy material maintained at the Coimbatore Station. The plots were laid out in the A B B A pattern and replicated four times. The data were analysed statistically and the differences regarding (1) weight of canes per row, (2) brix, (3) sucrose and (4) purity, were not found to be significant.

The above result is what might have been expected because, strictly speaking, deterioration cannot occur in Sugarcane varieties as the vegetative propagation is merely multiplication of the same individual without any change in the genetical make up.

Yield data of certain well known commercial canes maintained at the Java and at the Coimbatore Stations for over a decade are also presented and it is shown that their yields have not diminished.

The following four factors have, however, their own influence but there is no indication that the varieties, as such deteriorate. These factors are (1) envioronmental conditions, (2) bud variations, (3) reduction in soil fertility and (4) selective influence of diseases and pests and the part played by them is discussed in the paper.

No cane cultivator need fear that his popular variety is " sunning out " All that is necessary for maintaining steady yields is to see that the crop is kept free from pests and diseases and is planted in a soil, the fertility of which is maintained by suitable manuring.

6. A Preliminary Study of the Effect of Trace Elements on the Growth and Bud-Boll Formation in Vijay Cotton.

H. M. PATEL *and* D. K. PATEL, Baroda.

Preliminary pot experiments carried out to study the effect of Boron, Magnesium, Manganese and Zinc on the growth and bud-boll formation of Vijay cotton at two levels along with manurial NPK pot experiments, show that Manganese and Zinc give significant effect on the growth and bud-boll formation. Seed treatment experiments are in progress.

7. Diaeretus Aphidae, sp. nov. Parasitic on *Pterochlorus persicae* Chpldk, affecting Prunus Persica (Peach) in Baluchistan.

S. MUKERJI *and* S. N. CHATTERJEE, New Delhi.

The genus *Diaeretus* belongs to the family Aphidiidae the members of which are known to parasitise different species of aphids. The genus *Diaeretus* is one of the less studied ones among the genera of Aphidiidae. The parasite described in this paper was reared from the aphids—*Pterochlorus persicae* Chpldk, affecting peach as also from another type of Aphis affecting cabbages in Baluchistan. The species described is the first record of the genus from India, the only other sdecies *D. oregmae* Gahan described from the oriental region was collected from the Philippines.

The Indian species differs from *D. oregmae* Gahan in the number of joints in the antennae, length and thickness of pedicel as compared to the scape, number of joints in the maxillary palpi, shade and hairlessness of eyes ; position of the ocelli ; the strong, well developed tibial spur of the fore leg ; shape of stigma, size of radius and metacarpus in the fore-wings.

Figures of the head, thorax fore-wing, and female and male genitalia of the species given and descriptions are embodied in the paper to help in the correct identification of the species.

8. Relation between Some Analytical Constants of Ghee.

K. M. MEHTA, Jodhpur.

The chemical constants namely R.M., P.V., S.V. and I.V. have been determined in goat and sheep ghee and inferences drawn from their relationship. There is a wider limit between the constants of goat ghee than sheep ghee. In both there is a direct relationship between R.M. and P.V. though not as regularly as found in ghee of cow and buffalo. The saponification values in both cases vary in close limits and approach those obtained by workers in western countries. There is a direct relationship between I.V. and R.M. in goat ghee while this relation is inverse in the case of sheep ghee. In both cases

$$\frac{\text{S.V.}}{\text{R.M.}+\text{P.V.}+\text{I.V.}}$$

is a constant figure. This relationship can be beneficially utilised in detecting sophistication where goat and sheep ghee is mixed with cow and buffalo ghee.

9. Frequency of Cold Waves in India.

OOMMEN CHACKO, Poona.

Frequency of cold spells during the winters from December 1943 to February 1948 when the minimum temperature in the Stevenson Screen fell below 40°F is discussed in this paper. Frosty conditions are likely to exist in the open field when the minimum temperature in the Stevenson Screen falls below 40°F. It is shown that there is a variation in the intensity of cold waves as well as in the extent of the area affected during the various years. Winters during the period from December 1946 to February 1948 were comparatively milder.

10. The Study of Current Weather Week by Week during the Year in Relation to Crop Out-look and Phenology.

L. A. RAMDAS, A. K. MALLIK, T. S. GOVINDASWAMY
and P. V. PIMPALWADKAR, Poona.

The paper describes a striking method of representing diagrammatically the seasonal march of, as well as the marked abnormalities, in the major climatic factors in the various sub-divisions of India.

The purpose is to show how in any particular year, the march of the weather during the year is associated with the sequency of phenological events like (a) germination—tillering-growth—flowering—fruiting—harvest in the case of crops and (b) leafing, leaf-fall, flowering, fruiting, fruitfall, etc., in the case of trees. Each diagram relates to a particular meteorological element and shows at a glance how this element has varied week by week in the various sub-divisions of India *i.e.*, in the country as a whole. Such diagrams have been prepared for rainfall, maximum temperature, minimum temperature and relative humidity and will be shown at the meeting.

11. Entomological Investigations on the Leaf-Curl Disease of Tobacco in Northern India. VIII. Correlation between the Heights of Diseased Tobacco Plants and the Types of Leaf-Curl Virus causing Infection in the Field.

C. K. SAMUEL, New Delhi.

In the course of entomological investigations carried out at pusa (Bihar) on the tobacco leaf-curl virus during 1936-41 (Pruthi and Samuel, 1939, 1941), different diseased tobacco plants in the field were frequently observed to have a characteristic range of heights between certain limits. This phenomenon led to the assumption that a certain correlation could possibly exist between different types of leaf-curl and their corresponding heights. In order, therefore to make a detailed study of this correlation, if any, two varieties of cigarette tobacco, *i.e.* Harrison Special and I.P. Hybrid 142 were selected for comparison and the heights of a large number of healthy and leaf-curl infected plants in the fields of the Botanical Sub-station, Pusa, showing almost single types and their mixtures were carefully measured and recorded. The corresponding number of leaves present on those plants was also recorded.

Examination of the data thus collected showed that healthy plants were ordinarily the tallest in both the varieties. Among the four chief disease-types (A to D), A's average height in H-142 was less than half of its own height in H. Special. B's average height was even less than A in the latter variety, but almost same in the former. C was the tallest among all the types, and D was the next. AX was distinctly taller than either A or B. Among the mixtures AB, AC, and AD, AC was the tallest followed by AD and AB in both the varieties. The influence of C to increase the plant growth either alone or combined with other types (like B or D) was characteristic. In a mixture of A, C and D, the influence of C was mitigated to some extent by the presence of A although D also had a character similar to C to increase the height of the plant. Although the heights of the diseased plants were dependent on the types of leaf-curl affecting them, the total number of leaves present was not entirely dependent on the plant heights.

The data have been fully discussed.

12 Analysis of Agricultural Yields. II. Effect of Cultural Treatments on the Incidence of Gram Wilt (*F. Ortho-Ceras* Var. *Ciceri.*)

P. C. Raheja *and* G. P. Das, New Delhi.

Suitable adoption of cultural methods as a means to check the wilt incidence of gram has been investigated in a multiple-factor experiement comprising three days of sowing, three spacings and two depths of seeding. The data recorded on stand of the crop, its growth in height, flower production and yield per acre were interrelated to wilt incidence. The results derived were as under :—

1. Early wilt occuring within the first fortnight after germination was of low intensity than late wilt appearing in march.

2. Initially well grown plants were found to be more susceptible to wilt incidence. Non-wilted plants tended to make up in growth by a significantly higher rate of relative growth compared to the wilted ones.

3. Incidence of wilt made no difference either in the rate or total flower production of plants.

4. The incidence of wilt corresponds to the trends of the grain yield relating to the treatments of the dates of sowing and depth of seeding. Interspacing of rows made little difference in this respect.

13. Spray Programme for Controlling Anthracnose and Mildews of Grape Vine in Hyderabad State.

Syed Vaheeduddin, Hyderabad-Dn.

Several spraying and dusting experiments for the control of Anthracnose (Glaeosporium ampelophagum), Downy mildew (Plasmopara viticola) and Powdery mildew (Uncinula necator) were carried out in Aurangabad district for a period of 3 years. One row of 9 vines of the variety Bhokri was taken for each replication. The treatments were randomized and replicated 4 times. One row of vines was left untreated between every two treatments as buffer. Fair development of Anthracnose and Powdery mildew and little of Downy mildew on almost all the untreated vines was noticed, whereas the treated vines showed only traces of these diseases. Spraying with Bordeaux mixture and dusting with Sulphur gave the best results. Time and details of spraying and dusting have been indicated in the paper.

14. Influence of Ionic Diffusion in the Extraction of Soil Solutions by the Displacement Method.

C. Dakshinamurti, New Delhi.

The influence of diffusion on the displacement of electrolytes through capillary tubes has been studied. From geometrical considerations the diffusion is shown to be more effective at lower velocities of flow which correspond to the movement of soil water. This provides a theoretical basis for the displacement methods often used for the extraction of soil solutions.

15. Soils of Rann of Cutch and Possibilities of Reclamation.

J. N. Mukherjee *and* K. V. S. Satyanarayana, New Delhi.

In a very rapid reconnaissance survey the soils of Rann of Cutch have been examined on profile basis. The soils have been further examined in the laboratory for their mechanical constituents, salt content and nature of salt. The surface soils are silty clay in texture, which generally becomes lighter with depth. The pH of the soils is round about 8.0. The soluble salt content of the soils is high and apart from gypsum the salts consist mainly of sodium chloride, carbonates are practically absent and bicarbonate is uniformly low. The presence of gypsum in the soil and the availability of a large volume of water for washing out the salts indicate that at least considerable area can be reclaimed.

16. Study of Saline and Alkaline Soils of Rann of Cutch in relation to their Reclamation.

K. V. S. Satyanarayana *and* C. L. Kumar, New Delhi.

The soil samples relating to a saline and alkaline profile (Lakhpat-Piprala Profile) collected during a rapid reconnaissance survey of Rann of Cutch were leached with water and the changes in soil reaction were followed. It was found that successive leaching shifted the pH to the alkaline side and further leaching brought down the pH. It was noticed that the rate of leaching shows down in some samples. By successive washing out the soil in water suspension occupies a larger volume and finally some soils showed a dispersion. The dynamics of reclaiming this type of soils are considered.

17. Some Observations on the Interspecific Cross Luffa acutangula Roxb. X L. cylindrica (Lour.) Roem. (=*L. aegyptiaca* Mill).

H. B. Singh *and* B. P. Pal, New Delhi.

The F_1 hybrids raised by hybridization between *L. acutangula* Roxb. (both monoecious and hermaphrodite varieties) with monoecious *L. cylindrica* (Lour.) Roem.=*L. aegyptiaca* Mill were studied and the results reported. In the different crosses the progenies consisted of plants which were, either of the 'normal' or the 'abnormal' type. The 'normal' type resembled the parent varieties in general habit of growth, flowering and fruiting but fruits were bitter. The 'abnormal' type was characterized by compact habit, dark green puckered and irregular leaves, short internodes and abnormal racemes, the fruits being however free from bitterness like the parents. Both the types were 70-80% pollen sterile. The fruits were formed but the percentage of viable seeds was very low (5-10%). The hybrids of crosses with hermaphrodite varieties of *L. acutangula* produced purely monoecious type of flowers in the beginning but later were followed by the production of female flowers on the male receme and finally it was observed that hermaphrodite flowers also were produced in large numbers. These three types of flowers were localized in different positions in the inflorescence and such positions varied also. The 'normal' type hybrids (with hermaphrodite varieties) showed 57.5% increase in yield over the better parent (*L. acutangula*) and the 'abnormal' type showed a decrease of 28.8%. The increased yield is however not economically important as such plants invariably produced bitter fruits. The characters of *L. cylindrica* were generally partially dominant in the F_1. The 'normal' type F_1 produced normal plants in the F_2 whereas the 'abnormal' type produced both the types. The progenies were not economically promising.

The results of this hybridization study indicate that it may not be possible to select any new promising strains superior to the parent varieties, from this cross.

18. Indicator Plant Studies. I. Experiments with *Berseem* (*Trifolium Alexandrium*).

W. V. B. Sundara Rao *and* A. B. Ghosh, New Delhi.

The purpose of these investigations is to select suitable plants to indicate P_2O_5 deficiencies in the soil either by visual deficiency symptoms or by response in yields to the additions of P_2O_5.

Reddening of berseem plants has been ascribed as a deficiency symptom exhibited by the plants due to nutritional disorders. In the first year 1946-47, pot culture studies were conducted with a soil having 0.027% available P_2O_5 and not much of reddening was observed. Maximum growth was observed with pots receiving 150–200 lbs. P_2O_5 per acre showing thereby that the available P_2O_5 was not enough and a further application of 150 lbs. P_2O_5 per acre to the soil was necessary to meet the demand of this legume for vigorous growth, though the P_2O_5 content of the soil was not so low as to introduce deficiency symptoms in berseem.

In 1947-48 two soils were taken, (1) with an available P_2O_5 content of 0.003% and the other with a content of 0.023%. P_2O_5 was added in various doses from 0 to 250 lbs. at 50 lbs. intervals, with or without basal dressings of $N_{20}K_{50}$and $N_{60}K_{150}$ per acre respectively. With soil (1) low in available P_2O_5, 40% plants showed reddening symptoms in cntrol, which decreased to 2.5% and nil with 200 and 250 lbs. P_2O_5 per acre. With $N_{60}K_{150}$ basal dressing a decrease to 9% was observed even with 150 lbs. of P_2O_5, the figure being 1% with P_{200}. Basal dressing of either $N_{20}K_{50}$ or $N_{60}K_{150}$ alone did not reduce appreciably the percentage of plants showing reddening symptoms (41% and 34%). With soil (2) richer in available P_2O_5 the percentage of plants showing these symptoms was only 14 for the control. P_2O_5 at 150 lbs. per acre alone reduced it to 10% which along with a $N_{60}K_{150}$ dressing further went down to 4%.

After the first cutting the symptom practically disappeared and the number of red plants did not exceed 2% in any of the treatments.

However, in a field experiment reddening symptoms in berseem were found to be associated with extreme deficiency of N. Thus the reddening symptoms as discussed in a separate paper by Rao and Tejwani may be either due to extreme deficiency of N or P.

In the soil with low available P_2O_5 content, significantly increased yields (90% over no manure) were obtained with P_{100} and maximum yield (100% over no manure) with P_{250} among all the doses tried. The basal dressing $N_{60}K_{150}$ was superior to $N_{20}K_{50}$ and to control. P_2O_5 singly gave better yields than N and K treatments. NPK and NP proved better than P alone. Potash effect was not significant as judged by comparing the yields due to NP and NPK treatments. With the second soil riche in available P_2O_5 26% and 33% increases in yields were obtained with 150 and 200 lbs. P_2O_5 per acre. The effects of the basal dressing of $N_{60}K_{150}$ was to raise the yield at each dose of P_2O_5 compared to the corresponding doses at $N_{20}K_{50}$ and N_0K_0 levels in both the soils.

The control in the second series gave more yield than even an application of 250 lbs. P_2O_5 in the soil having low P_2O_5 content, showing thereby that more yields might be obtained in soil 1 by further increase in the doses of fertilizers.

19. Indicator Plant Studies. II. Experiments with Maize (*Zea mays*).

W. V. B. Sundara Rao *and* A. B. Ghosh, New Delhi.

Maize plants grown in greenhouses have been observed to indicate N-deficiency by its pale green foliage, stunted growth and the older leaves drying up rapidly from the tips (firing). The plants also indicated P-deficiency by its dark green foliage, lack of growth and violet streaks appearing occasionally on the leaves.

Studies were conducted with two Delhi soils, the first one having low and the other high available P_2O_5 (0.003% and 0.023%). Apart from the visible deficiency symptoms, the plants showed very distinct responses in yields due to N and P. With the former soil low in available P_2 O_5 NPK (at 100 lbs. per acre doses of each) gave 3½ times more yields than that of no manure, N alone giving 1½ times, NK giving twice. The yield due to P alone was 30% higher than that receiving no manure. The corresponding figures with the latter soil richer in available P_2O_5 were 3 times, 1¾ times, twice and 20% more than that of no manure. All the yields were better than the corresponding ones in the first soil indicating the higher fertility status of the second one.

Thus it was observed that a plant like maize, having high N-requirement for its growth, very easily indicated its deficiency both by visible symptoms and more by the response in yields.

Apart from the above observations, the available P_2O_5 status in the two soils were also judged from the fact that the yields due to NPK and NP in soil (1) were comparable to NK and N in soil (2) respectively. The percentage rise in yields due to the addition of P were as follows in the first and second soil respectively.

	Soil 1.	Soil 2.
Percentage increase from control to P.	34%	20%
„ „ „ N to NP.	105%	48%
„ „ „ NK to NPK.	74%	56%

The effect of P in increasing the crop yield was morepronounced in the soil which was more deficient in this nutrient.

20. Influence of Fertilisers on Crop Yields, Crop Composition and Soil Fertility when Legumes are either included in or excluded from the Rotation. Part I. Crop Yields and Soil Fertility.

S. V. Desai, W. V. B. Sundara Rao *and* K. G. Tejwani, New Delhi.

These studies have been carried out in lysimeters where two systems of rotations were started in 1945-46 *Rabi.*

(a) Legume rotation—Berseem (1945-46 *Rabi*)—Cowpeas (1946—*Kharif*)—Wheat (1946-47 *Rabi*)—Cowpeas (1946 *Kharif*).

(b) Cereal Rotation—Wheat (1945-46 *Rabi*)—Maruwa (1946 *Kharif*)—Wheat (1946-47 *Rabi*)—Maruwa (1947 *Kharif*).

The treatments in legume rotation were no manure in lysimeter 1 and superphosphate in lysimeter 2. The treatments in cereal rotation were no manure in lysimeter 3, N as sulphate of ammonia in lysimeter 4, P as superphosphate in lysimeter 5, and NP in the above forms in lysimeter 6. The doses of fertilisers and other details were given in the detailed paper. Only the first crop in both the rotations was manured and the residual effects were studied on the succeeding crops.

The conclusions arrived at are summarised below :-

In the *cereal rotation* the N treatment gave better yield, (24% more) than no manure, P treatment gave slightly more yield, while NP treatment gave the best yield (70% over no manure). No residual effects were observed on the succeeding crop except that the wheat crop in the lysimeter where N treatment was given to the first crop, gave 37% more yield than that obtained in untreated lysimeter and the crop in lysimeter 5 receiving P in first season gave 37% less yield than untreated lysimeter.

In the *legume rotation* P treated berseem in lysimeter 2 yielded 230% more fodder than that in untreated lysimeter 1. Succeeding cowpea in lysimeter 2 gave 103% increase over that in lysimeter 1, wheat in lysimeter 2 gave 21% less yield than that obtained from lysimeter 1. There was no residual effect on succeeding cowpea crop in 1947 *Kharif*.

Comparing the residual effects on the 3rd crop of wheat in the cereal rotation with those on wheat in legume rotation it was observed that the latter gave better yield than the former.

Another legume rotation was started in 1946-47 Rabi in lysimeters 7 and 9. Lysimeter 7 was unmanured and lysimeter 9 received P_2O_5. The seed rate was doubled. The P treated berseem gave 81% more yield than that obtained from unmanured lysimeter. The cowpea crop in lysimeter 9 gave 39% less yield than that in lysimeter 7. The wheat crop in lysimeter 9 gave 28% more yield than that obtained from lysimeter 7.

As the 2nd series of cereal rotation in lysimeters 3, 4, 5, and 6 was started at the time the residual effects were being studied in lysimeters 7 and 9, we had an opportunity to compare the direct effects of manuring wheat with the residual effect of manuring berseem on the third crop of wheat in the rotation. The direct effects of manuring wheat were similar to those observed earlier. The wheat in the legume rotation gave better yields than wheat in NP treatment which was the best among the cereal rotation treatments.

From this investigation it is felt that it is possible to build up soil fertility by introduction of legumes in the rotaion and possibly more so by phosphatic fertilization of legumes. By introduction of legumes in the rotation we get more fodder for animals and more food for man from the same area of land and still we maintain and improve the soil fertility better than that when we practice a purely cereal rotation.

21. Influene of Fertilisers on Crop Yields, Crop Composition and Soil Fertility when Legumes are either included in or excluded from the Rotation. Part II. : Crop Composition, Removal of Nutrients by the Crops and Crop (wheat) quality.

W. V. B. Sundara Rao, S. V. Desai *and* K. G. Tejwani, New Delhi.

The fertiliser treatments and cropping systems and their influence on crop yields are described in Part I. In this paper the influence of fertilisers and different rotations on the crop composition, removal of nutrients by the crops and crop (wheat) quality are described.

1. In the cereal rotation NP-treatment increased the N and P_2O_5 content of wheat grain (1945-46) and removed maximum amount of N, P_2O_5, K_2O and CaO from the soil. Wheat from this treatment was best in quality with maximum protein content, maximum test weight and very good general appearance. No residual effects of manuring were observed on the succeeding maruwa crop (1946) and adverse effects of P application singly were observed on wheat following maruwa.

2. In legume rotation P fertilisation of berseem (1945-46) increased the P_2O_5 content. While a dose of 100 lbs. P_2O_5 per acre did not increase the CaO content, a dose of 200 lbs. P_2O_5 per acre incrased it. The nitrogen content was unaltered. These treatments enabled berseem to remove N, P_2O_5 and CaO in larger quantities than those removed by untreated berseem.

Cowpeas (1946) after P treated berseem removed more N, P_2O_5, K_2O and CaO than that following untreated berseem.

Wheat (1946-47) following cowpeas after P treated berseem removed less quantity of nutrients than that following cowpeas after untreated berseem.

3. However the nutrients removed by wheat in either of the treatments in legume rotation were more than those removed by the 3rd crop wheat (1946-47) in

any of the lysimeters devoted to cereal rotation when the residual effects of manuring the 1st wheat crop (1945-46) were in evidence.

4. Berseem seed rate was increased to 60 lbs. per acre in a new series of legume rotation started in 1946-47 in lysimeters 7 (unmanured) and 9 (P treated) since it was felt that 30 lbs. seed rate used earlier was not enough to build up better fertility in P treated lysimeter than in untreated lysimeter as judged by the yields of wheat crop following cowpea after berseem. As in the earlier experiments, P treated berseem (1946-47) removed larger amounts of N, P_2O_5, K_2O and CaO than untreated berseem. Cowpeas (1947) following the P treated berseem removed less amounts of nutrients than those removed by cowpeas after untreated berseem.

5. Wheat (1947-48) in P treated berseem rotation removed more nutrients and was of better quality as judged by test weight, protein content and general appearance than wheat obtained from untreated berseem rotation.

6. Berseem was grown in 1947-48 in lysimeter 1 (untreated) and P (super at 200 lbs. P_2O_5 per acre) to see whether this dose of P_2O_5 would give increased yield of berseem, cowpeas and wheat, as with 100 lbs. P_2O_5 dose, in one trial (1945 to 1947), yield of cowpeas (second crop in the rotation, 1946) crop were more and yield of wheat (1946-47, 3rd crop in legume rotation) were less and in the other (1946 to 1948) cowpeas (second crop in the rotation, 1947)and wheat (third crop in the rotation, 1947-48) were greater than the yield of corresponding crops in unmanured berseem rotation. This rotation is in progress.

7. In 1947-48 the residual effects on wheat in legume rotation in lysimeters 7 and 9 and the direct effects of manuring with O, N, P, and NP on the wheat crop in the cereal rotation (1st crop in the second series of cereal rotation) were studied. It was observed that wheat grain in legume rotation removed more nutrients and gave grain of better quality than wheat grain of any other treatment in the creal rotation.

8 From this investigation it is felt that it is possible to build up soil fertility by introduction of legumes in the rotation and possibly more so by phosphatic fertilisation of legumes. By introduction of legumes in the rotation we get more nutritious fodder for animals and more nutritious food for man from the same area of land and still we maintain and improve the soil fertility better than that when we practice a purely cereal rotation.

2. Influence of Fertilisers on Crop Yields, Crop Composition and Soil Fertility when Legumes are either included in or excluded from the Rotation. (Lysimeter studies). Part III. Soil and Leachate Analysis as a Measure of Soil Fertility.

K. G. TEJWANI, W. V. B. SUNDARA RAO *and* S. V. DESAI, New Delhi.

The fertilizer treatments and cropping system are described in part 1 of the investigations.

The conclusions arrived at in connection with soil analysis and amount and nature of leachates obtained in differently treated and cropped lysimeters are discussed in this paper.

The main conclusions are summarised below :—

Soil analysis :

(1) The crops grown on soils under investigation gave a response to the addition of phosphate even though the soil contained more available P_2O_5 than the known limiting value (0.01%). This indicated the need for refixing the limiting values for various nutrients for different crops and soils.

(2) The differences in soil fertility status of lysimeters differently treated and cropped could not be obtained by chemical analysis of soil analysed by the known methods. However, these differences were best illustrated in the crop responses and removal of nutrients by the crops. In view of this the soil samples will be taken at longer intervals and not every season.

Leachate analysis—

(3) Leachate was obtained only during *kharif* season (May to October) period of heavy rainfall in Delhi.

(4) Leachate obtained in the years 1946 and 1947 was not large whereas the same obtained in 1948 was considerable in amount. The follwoing observations may be made on the analytical data of leachate obtained in 1948 *kharif*.

(a) Cereal rotation lysimeters gave more leachate than that given by legume rotation lysimeters.

(b) Nitrogen in the Leachate was in the form of Nitrate, Ammonical nitrogen being absent.

(c) Among the bases calcium was found in largest quantities.

(d) Potassium and phosphate were absent.

(e) There was more loss of calcium in lysimeter treated with sulphate of ammonia and this loss was reduced when superphosphate was added along with sulphate of ammonia.

(f) In legume rotation also the loss of calcium was more in untreated lysimeter than in P treated one.

(g) Loss of calcium in legume rotation was much. Less than that in cereal rotation.

23. Virus Diseases of Indian Potatoes.

PUSHKAR NATH, Simla.

Out of 28 distinct varietes of potatoes under commercial use in this country 24 were individually studied at the Simla Potato Breeding Station for presence of leaf-roll, virus X and virus Y.

Leaf-roll was found to be the most common cause of degeneration of seed-stocks. While most of the varieties when infected showed a marked reduction in vigour yet a few of like *Phulwa* (Variety 1), *Italian White Round* (Variety 20) appeared to be highly tolerant. Out of 24 varieties examined, 23 were found to be susceptible and only one type *Sathoo* (Variety 12) was highly resistant under field conditions.

Sixteen varieties were found to be susceptible to virus X and in the remaining no virus X has yet been recovered. Virus X by itself did not appear to cause markedly severe effects.

Virus Y was recovered from 19 varieties and, in many cases, in combination with virus X. Effects of virus Y were usually severe. The infected plants showed severe mottling and reduction in vigour. In combination with virus X it often caused severe rugose mosaic.

While presence of virus A was established it has not yet been studied in detail. It usually appears in combination with virus X, thus causing severe crinkle disease of the potatoes.

24. Studies on Penicillin Producing Strains of *Penicillium notatum chrysogenum* Series in India.

M. L. GATTANI *and* T. N. KAUL.

Studies were undertaken to produce penicillin producing strains of *Penicillium notatum chrysogenum* series at the Indian Agricultural Research Institute, New Delhi. To find out the incidence of*Penicillium* in soil throughout the year soil samples collected from potato fields of the farm and behind the Mycology Division, I.A.R.I. were plated out on Lipman and Browns synthetic medium. . A seasonal variation in the incidence of *Penicillium* was noticed. Penicillium was abundant in soil samples collected during

November and March, where as no *Penicillium* was obtained from samples collected during the second half of May, June and July. During these months, Aspergilli and specially *Aspergillus niger* was the most predominant fungus. Isolated colonies of *Penicillium* were first of all obtained from soil samples collected during August.

A number of strains of *Penicillium* were next isolated from soil samples collected from different parts of the plains of Nothern India during winter. This was made possible by making soil streaks on a selective medium, potato dextrose agar containing common salt in the proportion of three mols of common salt to a litre of the medium.

The strains so isolated were tested primarily for their penicillin producing ability. For this a simple apparatus was devised in the Mycology Division. It consists of a 15″×4″ bottle from which the bottom has been removed. The bottle is fitted with an atomizer containing a twentyfour hour old culture of *Staphylococcus aureus*. Petri plates with three equidistant markings on rim and containing a four day old culture of the strain of *Penicillium* isolated from the soil are attached to the bottomless end of the bottle. In order to ensure uniform distribution of the bacterium the experimental plate is so arranged that one of the marks coincides with another mark made on the end of the bottle. A spray is then given by the atomizer, the plate rotated one third its circumference, adjusted a second time and the process repeated so that each plate receives three sprays. The plates so sprayed are incubated at 37°C and the the strains producing inhibitory zones are selected. So far twentyfive strains have been selected and some of them appear to be very promissing with regard to penicillin production. Further studies are in progress.

Pages 191 to 202 Printed by Kalipada Mukherjee at Eka Press, 210, Cornwallis Street Calcatta.

36TH INDIAN SCIENCE CONGRESS : ALLAHABAD : 1949.

ABSTRACTS

SECTION OF PHYSIOLOGY

President : Dr. B. B. Sarkar, D. Sc., F. R. S. E.

1. Comparison of Invertase Activity of dried yeast with that of the purified Enzyme.

M. M. Biswas, Calcutta.

100 gms. dried Brewers' yeast powder was mixed with 150 c.c. water and the paste formed treated with 20 c.c. toluol and stirred with a rod at 30°C. for ¾ hr. to make a thin sludge. On autolysis the mixture was diluted with 200 c.c. water at 30°C. and kept for 1 hour. 4 c.c. toluol was added and this autolysed mixture was used for experiment. Portion of this mixture was filtered with kieselguhr under suction. The filtrate was examined for Invertase activity. Residue on the filter was extracted with water, treated with acetic acid to remove the proteins and after filtration with Kieselguhr was neutralised with ammonia. This filtrate was also tested for Invertase activity. Proportion of yeast powder and amount of glucose liberated were plotted in each case. Curves show the superior Invertase activity of crude yeast powder and the richer percentage of enzyme in the primary extract than in the secondary one.

2. On the Deterioration of Pepsin in Solution.

U. P. Basu *and* N. Ray, Calcutta.

Pepsin, though not unstable in dry condition is extremely unstable and susceptible to chemical alterations in solution. It is destroyed by alcohols, acids, alkalies, heavy metals and excessive heat. In ensuring its potency in any pharmacopoeial preparation the National Formulary (Eighth Edition, 1948) prescribed double the amount of pepsin claimed. Horkheimer (*Chem. mbs.*, 1936, **30**, 4622) found that incorporation of tannin with 3 per cent alcohol ensures the stability. Working with a granular variety of pepsin (1 : 10,000) it was noticed in the laboratory that the pH of the solution of pepsin is much more important for stability of the enzyme. The nature of anion plays no appreciable part in its deterioration on storage. Alcohol as well as dissolved oxygen tends to inactivate pepsin in solution. The addition of suitable antioxidants like ethyl galbate helps in preserving the enzyme in elixir.

3. Effect of Sodium Acetoacetate on the Enzymetic Hydrolysis of Polysacharides.

M. C. Nath *and* V. G. Hatwalne, Nagpur.

(1) The amylolytic activity of takadiastase on starch and glycogenolysis in rat liver (by perfusion experiments) were studied under the influence of Na-acetoacetate.

(2) Na-acetoacetate was found to inhibit the hydrolysis of starch at and above 0.0004M concentration. Below this conc. it was accelerated to a very small degree.

(3) Glycogenolysis in rat liver has been shown to be accelerated by Na-acetoacetate.

(4) The enzymetic breakdown of vegetable and animal starch is affected differently by aceto acetate; while the former is inbibited the latter is accelerated.

(5) The depletion of glycogen content and formation of more sugar than can be utilised in the case of a diabetic patient has been explained through the data obtained in the perfusion experiment with liver.

4. Thiamine Hydrochloride and its Deterioration.

N. Ray, Calcutta.

It is known that thiamine hydrochloride undergoes deterioration in solution. Working in this direction it is being observed that apart from the pH of the solution the dissolved oxygen and traces of heavy metals also play a significant role in its change. The mode of such alteration has been discussed and a modified method of its easy estimation by the iodometric titration after oxidation of the Vitamin with alkaline potassium ferricyanide has been offered.

5. Radioactive Methionine and Detoxication of Bromobenzene.

D. P. Sadhu, Calcutta.

Rats were fed methionine with radioactive sulphur of 4,000—5,000 counts/minute. They were, besides, fed either bromobenzene mixed with cotton seed oil or cotton seed oil alone. These were killed after 24 hours and radioactivity estimated in blood plasma, liver, muscle, kidney and intestinal mucosal proteins and in the inorganic sulphate and total sulphur of urine.

About 18 per cent radioactive sulphur is excreted in urine of normal rats, while 25 per cent is excreted after feeding bromobenzene...This indicates that more methionine is converted into cysteine, if there is an immediate need for it in emergent conditions. Standard specific activity (SSA) in different body proteins shows very little significant difference, although it tends to be higher in liver in bromobenzene feeding where most of the detoxication and conversion of methionine into cysteine occurs. SSA tends to be lower in intestinal mucosa and plasma, which latter is in dynamic equilibrium with tissue proteins. Thus the incorporation of methionine into tissue proteins is retarded when there is extra demand for conversion into cysteine.

6. Cysteine-Methionine Inter-relationship.

D. P. Sadhu, Calcutta.

Two groaps of rats were fed methionine with radioactive sulphur with a total count of 9050 per rat per minute, one group, besides, being fed a 2 per cent cystine diet. Radioactivity was estimated in brain and the proteins of blood plasma, liver, muscle, kidney, intestinal mucosa and in the inorganic sulphate and total sulphur of urine, 24 hours after feeding radioactive methionine. Cystine-fed rats had a high count in urinary total sulphur and inorganic sulphate and a low count in tissue proteins. This appears to indicate that it is not methionine, but largely its final product cystine, that is incorporated in tissue proteins and if cystine is already fed in excess in diet, methionine is exereted partly as neutral sulphur and partly oxidised as inorganic sulphate and excreted in urine. Kidney proteins show an increase in count in cystine-fed rats due presumably to the fact that more of the methionine fed was being excreted than in the control group. Brain also shows an increase in count probably due to the formatioj of a larger amount of sulpholipides in the cystine-fed rats and partly to retention of methionine-metabolic products in the brain tissue, where dynamic exchange may be less pronounced.

7. Glucuronidase Activity under different conditions.

D. P. Sadhu, Calcutta.

Glucuronidase activity was estimated in liver homogenates of albino rats by measuring the quantity of phenolphthalein liberated from phenolphthalein glucuronide. Young rats fed 10% tyrosine had a higher activity than the normals, this being corrected by feeding thiourea, though not thiouracil. Vitamin A—deficiency raises the activity, while hypervitaminosis A lowers it. Adult rats show similar but lesser changes. Difference in action between the two goitrogens, thiourea and thiouracil, is probably due to the structure of thiouracil being similar to that of tyrosine and both are probably excreted is glucuronide.

8. Tyrosine Toxicity in Young Rats.

D. P. Sadhu, Calcutta.

Tyrosine fed in excess (10% of diet) produces pathological symptoms in young albino rats of about 3 weeks, as loss in weight, exudative blepharitis, lesions in cornea, etc. The condition is not improved by feeding 0.2% ascorbic acid, slightly improved by feeding 500 I. U. of vitamin A, markedly improved by 0.2% thiourea or thiouracil, though less so by thiouracil, but worsened by feeding thyroid powder. Amino acid imbalance produced by feeding 10% glycine or glutamic acid in the diet had no effect other than a smaller gain in weight. Histological examination of rat thyroid, fed tyrosine shows marked cellular hyperplasia with very few vesicles.

Tyrosine toxicity in young rats appears to be mostly due to marked thyroid hyperplasia and increased secretion of thyroid hormone. Goitrogens as thiouracil and thiourea improve the condition by depressing the overactivity of thyroid. Difference in action between thiourea and thiouracil is probably due to difference in chemical structure, thiouracil being similar to tyrosine.

9. Studies on Riboflavin Excretion by Normal Indian Adults.

B. V. Rama Sastri *and* V. N. Patwardhan, Nutrition Research
Laboratories, Indian Research Fund Association, Coonoor.

There is much individual variation in the twenty four-hour urinary excretion of riboflavin. The range of fifty observations on 24-hour urinary excretion of riboflavin was found to be

343-4401, μ.g., the average being 1313 μg. Riboflavin excretion per unit volume of urine shows less variation, the range being 0.26 to 0.92 μg. per ml., the average being 0.58 μg. per ml. A large majority (about 75%) of the excretions fell between 0.3-0.7 μg. of riboflavin per ml. of urine. The values of riboflavin per ml. in fasting one hour samples agreed well with the corresponding figure calculated from the twenty four-hour excretion by the same subjects on unrestricted diet.

These observations confirm some previous findings that twenty four-hour urinary riboflavin excretions have got limited significance. There seems to be some justification for considering the riboflavin excretion per unit volume of urine in a fasting one hour specimen as an index of the level of riboflavin excretion in normals.

10. Study of the Bio-Chemical Aspect of Etiology of Phrynoderma.

P. G. Tulpule *and* V. N. Patwardhan, Nutrition Research Laboratories, Indian Research Fund Association, Coonoor.

In recent years evidence has been produced which throws doubt on the accepted hypothesis concerning the etiology of Phrynoderma (Follicular Hyperkeratosis). The question has been raised whether it is due to a simple deficiency of vitamin A or there are some other factors involved such as the related deficiencies of certain members of vitamin B_2 complex and essential fatty acids.

Taking into consideration this controversy, an investigation of the biochemical aspects of the disease has been undertaken. So far, nine patients have been studied. Analysis of the blood for lipoids—total lipoids, cholesterol, total fatty acids and Iodine Number of total fatty acids—and carotene and vitamin A were made before instituting the treatment. It was observed that the Iodine Number of the fatty acids of blood was considerably lower in phrynoderma patients although the total lipoids and cholesterol content of the blood was practically normal, indicating some disturbance in fat metabolism. The range of the Iodine Number of blood fatty acids in normals has been observed to be between 108 and 135 as against 74 and 87 in the patients suffering from phrynoderma. The clinical response of patients treated with shark liver oil from which vitamin A was destroyed has been favourable. It is intended to analyse the blood lipoids after the treatment is complete.

11. Poor Indian Diets and Adult Hepatic Chirrhosis.

P. K. Vijayaraghavan *and* V. N. Patwardhan, Coonoor.

Inspite of extensive work on the effect of various dietary factors on liver disease, doubt still exsists regarding the exact conditions resulting from nutritional deficiencies, which lead to hepatic cirrhosis and necrosis. With a view to studying the role of poor Indian dieteries in the production of portal cirrhosis certain experiments were started. Albino rats, four weeks old, were fed on poor Indian diets based on rice and wheat respectively. Metabolic studies consisted in determining urinary Nitrogen, fecal nitrogen, and total sulphur and SO in urine. Studies on liver consisted of the determination of total crude fatty acids, total protein, carotene, vitamin A, thiamin and riboflavin, at the end of 2, 4, 6 and 9 months.

The total crude fatty acids of liver of the animals kept on the South Indian diet, with 10% protein and low fat content, after an initial increase diminished after six months. But in wheat diet I, which had the same protein and fat level, the lipid content showed a steady increase. Wheat diet II, having a slightly higher protein content, also showed a steady increase during this period. In the control group, however, there was only a slight increase.

It is interesting to note that on both rice and wheat diets liver fat increased to 10% or over, although the dietery fat was in the neighbour of 4%. In the rice diet the liver fat started fallingtill the end of nine months it approximated the fat content of livers on the stock diet. Whether these changes in the liver are accompanied or followed by structural changes will be revealed by the histological examination of liver, which is being carried out.

12. Conversion of Carotene to Vitamin A.

A. R. Sundararajan, Nutrition Research Laboratories,
Coonoor.

It was assumed till a couple of years ago that liver is the principal seat of conversion of carotene to vitamin A in the animal body. Recently some evidence has been brought forward to show that intestinal wall may be a site of conversion when carotene is ingested. The following experiments were carried out to locate the exact site of conversion.

Vitamin A-deficient young rats were divided at random into three groups. The first group received only ten drops of gingelly oil containing 0.5% of a-tocopherol acetate ; the second received 4.375 mg. of carotene (88% B-carotene) dissolved in 10 drops of gingelly oil. The third group received the same solution as the second but with a prior dosage of sulpha suxidine for two days. The rats were killed at varying intervals of time and the organs assayed for carotene and vitamin A.

Vitamin A appeared in large amounts in the lumen of the small intestine up to 5 hours. During this period, there was no increase in liver of either carotene or vitamin A after the fifth hour, up to 48 hours, liver vitamin A increased while that of the small intestine (wall and contents) returned to the pre-dose level. Although the vitamin A levels of the wall of the small intestine also increased with that of its contents, the figures for the latter were far in excess of the former. It is concluded that in the vitamin A-deficient albino rat, when carotene is fed by mouth, its conversion to the vitamin takes place in the lumen of the small intestine and that the liver acts only as a storage organ. Further investigations are in progress.

13. Impairment of Antibody Production during Vitamin B6 deficiency in the Chick.*

P. S. Sarma, Nutrition Research Laboratories,
Coonoor.

It has been shown by several workers that a relationship exists between the state of nutrition and antibody production in the rat. Thus Stoerk and coworkers and Axelrod and others have found that in vitamin B- deficiency in rats the production of antibodies is slowed down to a considerable extent. A significant decrease also takes place in the thymus weights of these deficient rats.

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*(This work was carried out in the Department of Nutrition, Haward University School of public health, Boston, Massachusetts.)

It was felt that these results needed confirmation in another species of experimental animals. It was found that chicks normally possess a high antibody titre against washed sheep blood erythrocytes. Day old chicks were fed chline deficient diet, pyridoxine deficient diet and pyridoxine deficient diet to which desoxy-pyridoxine, the anti-vitamin, was added in suitable amounts. When the chicks exhibited signs of vitamin deficiency, washed sheep blood erythrocytes were injected and the haemagglutinins were determined after an interval of five days. The thymus, spleen and bursa Fibrici were also removed from each chick and their weights determined. The results clearly demonstrate that during vitamin B-deficiency, there occurs an impairment of antibody production and the weights of thymus, spleen and Bursa Fabrici also get reduced to a considerable extent. No such changes were observed during choline deficiency in the chick.

14. Studies in Perotic Chicks with Radioactive Phosphorus.*

P. S. Sarma, Nutrition Research Laboratories,
Coonoor.

Chicks suffer from perosis or slipped tendon during several different types of nutritional deficiencies. This disease involves the bones and has some counterpart in certain bone diseases of children. Perosis is very marked in two entirely unrelated deficiencies, one a mineral deficiency—(manganese deficiency) and the other a vitamin deficiency (chlorine deficiency). It was therefore thought that a study of phosphorus metabolism in the bone could best be studied using radioactive phosphorus. Day old white Leghorn chicks were kept on purified rations deficient in chlorine and manganese respectively. When the chicks developed perosis, 50 microcuries of radioactive phosphorus was injected into the chicks and the chicks were then sacrificed at definite intervals of time. The tibia were removed, the organic and inorganic forms of phosphorus seperated and the radioactivity of samples determined with the aid of a Geiger-Muller counter and an autoscalder. Phosphatase activity was also determined in the serum of the chicks. The results obtained indicate that in perotic chicks, the rate of phosphorus turnover is far below that of normal animals. Further, the livers of choline deficient chicks are not fatty and the phosphatase activity of their sera is abnormally high. In contrast, the serum of manganese deficient chick was found to be abnormally low in phosphatase activity. These results has been discussed in their relation to the deposition of calcium and phosphorus in the epiphysis of the bones of chicks suffering from choline and manganese deficiencies.

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*Work carried out in the Department of Nutrition of the Haward University School of Public Health, Boston, Massachusetts).

15. Pyridoxine and Linoleic Acid Metabolism.*

P. S. Sarma, Nutrition Research Laboratories,
Coonoor.

Several workers have studied the relationship between pyridoxine and linoleic acid metabolism, but the exact nature of such a relationship has not been completely elucidated. In this paper, observations have been made on the occurrence of ring tail dermatitis in rats and on the growth retardation in chicks, which contribute additional evidence as regards the disturbance of linoleic acid metabolism during pyridoxine deficiency in both the rat and the chick. When Desoxy pyridoxine was added to a vitamin B- deficient diet at a level of 1 mgm. per 100 gm. of diet, Young growing rats invariably developed ring tail dermatitis along with the usual signs of vitamin B- deficiency within a very short period of three to four weeks. Ring tail dermatitis, popularly known as the 'Burr and Burr' syndrome is caused by a deficiency of linoleic acid and the observations carried out lead one to conclude that desoxy pyridoxine not only induces a severe derangement of tryptophane metabolism as indicated by an increased excretion of xanthurenic acid in the urine but also causes a disturbance in the normal metabolism of linoleic acid. The relationship between linoleic acid and pyridoxine has also been observed in chicks fed on diets deficient in pyridoxine and linoleic acid, the growth retardation of chicks on a combined vitamin B- deficient and linoleic acid deficient diet being greater than on vitamin B- deficient diet alone. No such difference in growth was observed in other vitamin deficient diets when linoleic acid was omitted from them.

16. Vitamin B Complex and Cutaneous Nutrition.

D. P. Sadhu, Calcutta.

Most of the works on the effect of vitamin B complex deficiencies on skin have been carried out with yeast as a source of vitamin B complex, but as it contains many substances, including protein and other unknown factors and as it is difficult, if not impossible, to produce pure single vitamin deficiency with yeast as a source of B vitamins, an experiment was undertaken with pure synthetic B vitamins in the diet.

Young albino rats of 40—50 gm. weight were placed on a purified diet, each group receiving all the pure vitamins except the one vitamin, to which they were to be made deficient. Five groups of rats were used, one serving as control which received all the B vitamins. Though the synthetic diet was optimal, it did not produce maximal growth. Thiamine-deficient rats had no cutaneous lesion except one rat in the group which showed some denudation of the neck and part of the thorax. Riboflavin-deficient rats did not show any skin lesions whatsoever. Pyridoxine-deficient rats started showing thinning of fur from the 8th day, red whiskers on 30th day, inter-digital reddening of legs on 44th and scaly paws on 60th day. Pantothenic acid-deficient rats were like the pyridoxine-deficient ones, but showed more extensive alopecia, involving not only the throat, but also abdomen and even the hind legs.

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* (This work was carried out in the Department of Nutrition, Harvard University School of Public Health, Boston, Massachusetts.)

The cutaneous nutrition is a function of both pyridoxine and pantothenic acid, the other vitamins as riboflavin and thiamine being not responsible for the nutrition of the epidermis.

17. Studies in Manganese Matabolism.

M. N. Rudra, Darbhanga.

The conditions which govern the retention of manganese by the tissues of animals have been studied. A group of white rats fed a basal ration and sodium-bicarbonate retained only 0.18 mg. of the 0.5 mg. manganese given to each daily. A similar group of rats given the same ration and manganese but ammonium chloride instead of sodium bicarbonate retained daily .30 mg. of the 0.5 mg. manganese given. The increased retention is statistically significant showing that acid condition favours retention of manganese by tissues. In both groups most of the manganese is excreted in the faeces. In the former .31 mg. (96.3%) of the excreted manganese is in the faeces and .012 (3.7%) in urine. The corresponding figures for the latter are .21 mg. (98.2%) and .004 mg. (1.8%) respectively.

18. Studies on Indian Edible oils—Sesame oil.

K. Rama Murti *and* B. N. Banerjee, Department of Biochemistry, Indian Institute of Science, Bangalore.

Samples of sesame oil obtained from all over India have been studied with special reference to the effect of the free fatty acid content of the oil on its digestibility, and the stability of carotene when dissolved in it. The values obtained have been compared with those of groundnut oil. It was observed that in the case of sesame oil there was a lower digestibility and greater in-activation of carotene as the f.f.a. of the oil increased. An oil of less than 1% f.f.a. showed digestibility comparable to that of fresh oil obtained from healthy seeds and caused very little inactivation of carotene. For the same degree of acidity, there was lower digestibility and greater inactivation of carotene in the case of sesame oil than in the case of groundnut oil. This can be explained as being due to the differences in the glyceride structure and unsaponifiable portions of the two oils. Experiments in this direction are under progress.

Experiments are also being conducted to study the stability of vitamin A in high f.f.a. sesame oil and the preservation of the latter with antioxidants.

19. Growth of Fibroblasts in Tissue Culture under the action of Vitamins.

N. N. Das, Department of Physiology, Calcutta University.

Hanging drop preparation of tissue culture from six day old chicken embryo showed marked differention in the fibroblastic growth under the influence of vitamin mixtures (A.B.C.D.). The growth was nearly double, after 48 hours incubation in the vitamin treated cultures. The vitamin treated cultures can be kept for a longer period than the untreated ones and are more resistant to infection. The applications of different concentrations of vitamins have been studied. The larger doses of vitamins have a lytic action on the fibroblastic growth. Further work on the action of individual vitamins is in progress.

20. Studies on the Mechanism of Alloxan Hypoglycemia.

Sachchidananda Banerjee, Calcutta.

When alloxan is injected intravenously in rabbits an initial hyperglycemia is followed by a transient hypoglycemia leading to death of the animals from hypoglycemic convulsion. If the hypoglycemia is prevented by repeated intravenous injections of glucose, animals survive and permanent hyperglycemia and diabetes develops in the animals. The transient hypoglycemia has been claimed to be due to leacking out of insulin into the circulation from the pancreas. Some workers, however, think that the transient hypoglycemia is extrapancreatic in origin. To throw some light on the mechanism of alloxan hypoglycemia the following experiments have been undertaken : Alloxan (200 mg. per kilo) was injected intravenously in four rabbits which were starved and which received a daily injection of 100 mg. of phloridzin for a period of seven days. The injection of alloxan produced an an initial hyperglycemia but no hypoglycemia was observed in any one of them. Twenty-four hours after the injection of alloxan all the rabbits excreted sugar in the urine and their fasting blood sugar level was high. Alloxan was injected in two rabbits made diabetic by a previous injection of alloxan. The injection of alloxan caused a further rise in the blood sugar level and even six hours after the injection of alloxan the blood sugar level was much above the fasting blood sugar value. Glucose tolerance tests were performed in a rabbit, both before and after the animal was phloridzinised and starved for seven days. A diabetic type of glucose tolerance curve was observed when the animal was phloridzinised and starved. The implications of the above results will be discussed.

21. Vitamin C and Thyroid.

Sachchidananda Banerjee *and* Naresh Chandra Ghosh, Calcutta.

Patients with hyperthyroidism have high blood sugar and show a hyperglycemic reaction after glucose. These are reduced after thyroidectomy. Thyroidectomy increases the carbohydrate tolerance and diminishes the insulin requirements of diabetic patients. Yhe glycogen value of the liver of animals are diminished when fed thyroid and increased when fed thiouracil, which is an antithyroid agent. It has been observed by us that scorbutic guinea pigs show a diminished sugar tolerance and diminished glycegen value of the liver. The metabolism of thyroid gland, therefore, might be disturbed during scurvy. The effect of feeding thyroid and methyl-thiouracil, an anti-thyroid agent, on the altered carbohydrate metabolism as observed in scurvy, have therefore, been investigated. Six groups of guinea pigs were placed on six different diets for a period of three weeks. The diets were (1) Scorbutic diet only; (2) Scorbutic diet containing 1 per cent methyl thiouracil; (3) scorbutic diet with 0.05 per cent thyroid; (4) scorbutic diet with a daily supplement of 5 mg. of ascorbic acid per animal; (5) Scorbutic diet with methyl thiouracil with a daily supplement of ascorbic acid and (6) scorbutic diet with thyroid with a daily supplement of vitamin C. The animals of all the groups were weighed wtice a week. Glucose tolerance tests were performed on the 22nd day of the experiment in all the animals of the different groups. The type of glucose tolerance curves of the three groups of guinea pigs, which received scorbutic diet, scorbutic diet with methyl thiouracil and scorbutic diet with thyroid, was more or less similar. The blood sugar values both before and for varying periods after the feeding of glucose did not vary significantly in these animals. This indicated that the deficient utilization of glucose as observed in scorbutic guinea pigs was not affected by either hypo-or hyper-thyroidism. The blood sugar level three hours after feeding glucose, in guinea pigs receiving thyroid gland and ascorbic acid was significantly higher than the blood sugar level in guinea pigs which received no thyroid gland. This indicated that hyperthyroidism lowers the carbohydrate tolerance in guinea pigs. Methyl-thiouracil howeiver, had no effect on the utilisation of glucose.

22. Supplementing Value of Calcium Fortified Groundnut Milk to a Poor South Indian Rice Diet.

M. N. Moorjani *and* V. Subrahmanyan. Department of Biochemistry, Indian Institute of Science, Bangalore.

It was shown that the groundnut milk has no supplementing value to a poor Indian diet. This is due to the fact that the milk is very deficient in calcium and that the proteins in the milk are of low biological value. An attempt was therefore made to study the supplementing effect of calcium fortified milk on poor rice diet. The fortified milk given as a, supplement to poor Indian diet increased the average weekly increase in weight of rates. from 2.5 to 6.2 gms. as compared with cow's milk where the average increase is 8.6 gmss The inclusion of 2% yeast into the milk gave still letter results.

23. Fortification of Groundnut Milk with Calcium and Study of its Availability to Young Albino Rats.

M. N. Moorjani *and* V. Subrahmanyan, Department of Biochemistry, Indian Institute of Science, Bangalore.

Groundnut milk is very poor in calcium (9 mgs. per 100 ml.) as compared with cow's milk (which contains about 120 mgs. per 100 ml.). An attempt was therefore made to fortify the milk with calcium in order to make it a nutritive article of human food. The incorporation of calcium into the milk offered some practical difficulties as th milk curdled on addition of even small amounts of calcium salts. The raising of pH of the milk from 6.0 to 6.6 and addition of 0.3 per cent of sodium citrate has a favourable effect on the calcium incorporation. Among the various calcium salts tried calcium glycerophosphate gave the best results. The milk was therefore fortified with calcium by incorporation of calcium glycerophosphate along with 0.3% Na-citrate at pH 6.6. The availability of calcium and phosphorus from fortified groundnut milk has been compared with those from cow's milk by conducting balance studies with young albino rats. It was found that the rats retained 72.7% of the calcium and 90.2% of phosphorus from groundnut milk, while the corresponding figures for cow's milk were 84.9 and 83 respectively.

24. Effect of Steaming on the Vitamin B-Complex of Groundnut Milk.

M. N. Moorjani *and* V. Subrahmanyan, Indian Institute of Science, Bangalore.

The overall vitamin B-complex value of groundnut milk has been estimated as being 80% of that in cow's milk. There the groundnut milk was used as such in the fresh form having a nutty flavour. Subsequent investigation showed however that the flavour can be completely removed by steaming the milk for about half an hour, and the milk thus obtained after steaming was found to have an agreeable flavour and taste reminiscent of pasteurised cow's milk. The vitamin B-complex in groundnut milk both before and after steaming were compared with that of cow's milk by growth experiments on rats. The average increase in weight over seven weeks (from the commencement of milk administration) was as 65.3, 52 and 46 gms. in the case of cow's milk, fresh groundnut milk (unsteamed) and steamed groundnut milk respectively. There occurs a loss of about 11.5 per cent in the B-complex vitamin content of groundnut milk on steaming it for about half an hour. To make up for this loss it would be desirable to incorporate B-complexes in some suitable form after steaming the milk.

25. On the Inhibition of the Acidity of Gastric Juice by Ergotoxine.

B. P. Sinha, Darbhanga.

An experimental observation on two Pavlov and one Heldenhain pouch animals on the response of a single dose of Ergotoxine grain 1/100 administered subcutaneously just after the intake of standard quantity of beef without extractive, showed that the drug had a remarkable inhibitory effect in both the quality (in acidity) and quantity of the gastric juice. The effect of which persisted even up to three hours.

26. The Theory of the Alpha-Phonoid (A Study of Speech Structure).

C. R. Sankaran.

Professor A. GOMELLI'S latest experimental findings regarding the structure of speech elements are given. The 'higher generalization' due to the Alphaphoneme theory which leads to the conception of further refinement known as the 'Alpha-Phonoid' theory is discussed in the light of some topological concepts. The continuum of the CV configuration which the 'Alpha-Phonoid' theory involves is a many dimensional continuum, and is a topological structure of manifoldness. The epistemological implication of the conception is touched upon.

27. Role of Potassium in some Irregularities of Perfused Frog Heart.

N. P. Benawari, Laheriasarai, Behar.

A few years back, while working on perfused frog's heart, it was observed that during the months of August, September and early part of October, the perfused hearts showed certain pecularities not observed during the rest of the year. There was increased coagulation of blood and marked irregularity in the amplitude and rhyrhm of beat, mostly in the male frogs.

An interesting thing was observed in this connection that when such irregular hearts were perfused with Ringer containing excess of potassium (0.1% instead of 0.03% of KCl) the heart quickly stopped, as expected, but on reperfusion with ordinary Ringer, recommenced beating without irregularity.

It seems rather odd that in the perfusion of frog's heart, specially males an excess of potassium is necessary during the breeding season. It is likely that the excess of sex hormones in the blood during the breeding season keep the heart beating regularly, inspite of lowered content of potassium in the cardiac muscle. When the blood is replaced by ordinary Ringer, the heart become irregular due to the low content of potassium in the heart muscle, which can be corrected by increased amount of potassium in the perfusing fluid.

28. On the Assay of Liver Extracts—Part II.

A. N. Bose,. Bengal Immunity Research Institute,
Calcutta.

Biological assays of potent liver extract preparations are difficult in the laboratory. There is no universally accepted method for evaluating such extracts. Attempts have been made on pigeons and guineapigs. It has been reported (Jacobson & Williams, Brit. J. Path. Bact. 1945, 57, 101) that splenectomised rabbits give rise to a very high reticulocyte response to injection of potent liver extracts. In order to find whether such splenectomised animals could produce response suitable for biological assay, a number of experiments were carried in this laboratory. Three splenectomised rabbits (wt. 1.5 to 2 kg.) were subjected to repeated injections of potent liver extracts of different brands (Lily, B.I., T.C.F. Evans) and their responses compared with those after injection of Casein Hydrolysate containing equivalent quantity of nitrogen per c.c. It is being found that a definite qualitative response is available by this method of assay. Further work is on progress to study the quantitative response of these animals to injections of different doses of Liver Extract.

29. Effects of Methyl Ester of the Fatty Acid from the Oil of Bouchi on the Depigmentation of Skin.

N. N. Das, Department of Physiology, Calcutta University.

Leucoderma or the white skin due to depigmentation is a condition of metabolic error, the effect of some abnormal conditions either pathogenic or non pathogenic. The ailment sometimes subside but the white patches of the skin does not disappear. A few cases have been tried with intradermal injection of the methyl ester prepared from the fatty acids from the oil of Bouchi at the site of the white patches. Cases treated with oil injections were compared with cases treated with methyl ester. In the later cases better and quicker results were obtained than in the former. Moreover the injection of oil cause pain and irritation, whereas the injected methyl ester is quickly obsorbed and is less irritating.

30. Action of Jute Seed Bitter (Chorcorin) on Smooth Muscle.

Nirmal Kumar Sen *and* N. N. Das, Department
of Physiology Calcutta University.

The action of Chorcorin on heart has already been studied. In the present paper its action on intestinal and uterine muscle has been studied. Strips of intestinal loop showed marked stimulation at perticular concentrations. A difference between the crude extract and the purified crystalline product has also been dealt with. The crude product contain certain other compounds which require further investigations.

31. Effects of Spirochin Hydrochloride on Toad's Heart and on the Blood Pressure of Cat.

S. R. Moitra N. N. Das *and* G. S. Chatterjee,
Department of Physiology Calcutta.

Its theraputic action on the toad's heart and on cat's blood pressure was studied. The toad's heart was perfused containing different concentrations of the drug. The amplitude of the heart was found to be diminished proportionately with the increasing concentration of the drug in the perfusing fluid. With strong concentration of the drug (5%) the heart stopped completely, but revived again when perfused with Ringer. The drug was found to paralise the vagus nerve.

The action of the drug on the blood pressure of cat revealed that in small doses there is a slight fall of blood pressure lasting for a short time when injected into the vein. The pressure quickly came back to normal. The lethal dose for cat is 0.3 gm. to 0.35 gm. per kilo. Respiration failed before the heart. The action of Vagus on blood pressure was found to be depressed by the drug.

32. A Method for the Production of Carotene Concentrate from Water Hyacinth (Eichhornia Crassipes Solms).

S. Neogi *and* K. Rajagopal, Calcutta.

In quite recent years several research workers, notably Sankaran, G. (1948), Sen, K. C. (1944) and Banerji, B. N. (1946) have mentioned the possibility of commercial production of carotene from water-hyacinth. Water hyacinth is regarded as a pest and its eradication is a serious problem in Bengal. According to official report about 107 million tons of green leaves are easily available in the province. In this abstract a simplified method for the production of carotene concentrate which has been worked out has been presented which is applicable to its production on a commercial scale. The method as finally established briefly consists of (1) blanching of the thinly sliced green leaves in boiling water for 2 to 3 minutes, (2) dehydration in a forced draft type dehydration or water oven maintained at a temperature below 60°C for 4 to 5 hours, (3) extraction by heating in boiling flasks on water bath with (80° to 90°) petroleum ether of high boiling point (80° to 90°C), (4) chromatographic separation of carotenoid fractions from chlorophyll and other non-active components,

(5) concentration and recovery of solvent by distillation under reduced pressure, (6) preservation and storage in vacuum sealed brown glass bulbs. The yield by the method has been found to be an average of 85 per cent of the total carotene content of the leaves (Spectroscopic method). By working with 3 kg. quantities or green leaves an average of 140 mg. of purified production have been obtained in the laboratory. Varying conditions at different stages involved in the process have been studied. The treatment of blanching has been found to hasten dehydration at 60°C by about 60 per cent and raise yields of carotene by about 42 per cent when compared with those obtained without the treatment. The progress of dehydration has been followed and curves have been drawn on the data. In the process of extraction several types of apparatus have been used, *viz.*, glass soxhlet (2 litre), copper soxhlet (3 litres) and long necked boiling flasks (2 litres) fitted with upright bulb condensers, with low (40°—60°C) as well as high boiling (80°—90°C) petroleum ethers. Comparative studies show that 4.7 to 4.8 mg./100 g. (fresh basis) which is 84—86 per cent of the carotene con;ant can be attained with direct heating in boiling flasks using high boiling petroleum studies show that 4.7 to 4.8 mg./100 g. (fresh basis) which is 84—86 per cent of the carotene content can be attained with direct heating in boiling flasks using high boiling petroleum ether. In chromatographic separation a mixed absorbent consisting of soda-ash and magnesium oxide in the proportion of 6 : 1 has been devised. Soda ash has been selected as it is cheaply available and selective in absorption (Kernohan, G : Science 90, 623, 1939) for chlorophyll and other non-carotenoid pigments. The rate of percolation has been seen to be more rapid in comparison with other absorbents and the chance of isomerisation is thus much reduced. After use the adsorbent has been dired in air and revivified with heat and used again for adsorption. Growth curves of rats fed different amounts of the product prepared in the laboratory showed biological activity of the pigment. Experiments are in progress on the administration of the carotene obtained in the laboratory as supplementary feeds to school children.

33. Studies on the Chromatophorotropic hormone of the Pituitary Gland : Part I—Isolation and Purification of the hormone.

B. Ghosh, J. N. Karkun, D. P. Sadhu *and* B. Mukerji, Calcutta.

The Melanophore by different methods and its hormone supposed to be located in the intermediate to be of the gland was extracted activity measured biologically on the isolated skin of frog (Rana), using a methoid analogous to that described by Frieman, Fishbein and Hisan (*Arch. Biochem.* 1948, **17**, 183). An acetic acid (0.5%) extract of whole pituitary powder representing 1 mg. of powder per c.c. has been arbitarily chosen to represent a standard of 100% activity. Dilute pyridine extract showed 50% activity while dilute ammonia extract recorded even lower activity. Extraction of melanophore homone from acetone dried whole pituitary gland was found to give on an average 50% activity. An acetic acid extract of fresh whole pituitary gland of on, representing 17 mg. of fresh tissue per c.c., possessed 240% activity. A study of the physico-chemical properties of the acetic acid extract of melanophore hormone revealed the following facts. The optimum activity of the hormone remained at pH 4.0. Diminution of activity resulted when pH of the extract was either lowered to 2.0 or raised to 8.0. Melanophore hormone, though heat-stable, cannot stand prolonged heat-treatment even at as low a temperature as 40°C. Complete destruction of activity was noted when the acetic acid extract of the pituitary was subjected to slow evaporation under hood at 40°C. Vacuum evaporation below 50°C caused slight but appreciable destruction of hormone activity. Different adsorbing materials like active charcoal, Decalso, Kaolin, calciumphosphate, permutit, and Kieselguhr have been tried. Active charcoal was found to adsorb completely the melanophore hormone. While Decalso was partially effective. Kaolin and Calcium phosphate were ineffective as adsorbing agents. Permutit, Fuller's earth and to a larger extent, Kieselguhr were capable of removing some associated pituitary constituent which seemed to possess anti-melanophore activity. Partial concentration of melanophore hormone by precipitation with acetone and ammonium sulphate has been effected. Acetone in sufficient quantity (1 : 4 by volume) was capable of producing precipitate which contained about 4.5 times melanophore activity as compared with that of the fresh tissue extract.

34. Chemotherapeutic action of Dimidium Bromide in T. Equiperdum and T. Evansi Infections.

B. N. Choudhury *and* B. Mukerji, Calcutta.

Wien (1) has studied the therapeutic activity of amidine and phenanthridinium compounds against T. congolense infections in laboratory animals. He has observed that phenanthridinium compounds which are highly active against T. congolense showed little activity against T. equiperdum in contradistinction to amidine compounds which show great activity against T. equiperdum but are ineffective against T. congolense. This observation led us to study the effect of Dimidium Bromide, a phenanthridinium compound, against T. evansi & T. equiperdum infections, the two strains maintained in our laboratory. The results are shown in Table I & II.

TABLE I.

Evaluation of the activity of Dimidium Bromide against T. evansi.

Dose—mg./gm.	No. of mice.	No. of mice cleared of Trypanosomes.	
		3 to 7 days.	28 days.
0.0005	4	0	..
0.001	4	0	..
0.005	4	0	..
0.01	4	0	..
0.02	4	0	..
0.03	4	2	..
0.04	4	3	1
0.05	4	4	3

TABLE II.

Evaluation of the activity of Dimidium Bromide against T. equiperdum.

Dose—mg./gm.	No. of mice.	No. of mice cleared of Trypanosomes.	
		3 to 7 days.	28 days.
0.01	2	0	..
0.02	2	0	..
0.03	2	0	..
0.04	2	1	..
0.05	2	2	2

From table I it will be observed that the E. D. 50 & C. D. 50 figures for T. evansi are 0.03 mg./gm. & 0.045 mg./gm. respectively. These figures are quite high compared to those for T. congolense (E. D. 50—0.00005 mg./gm. & C. D. 50—0.0004 mg./gm.—Wien (1)) and approach the toxicity figure by subcutaneous route (0.061 mg./gm. (Wien)—confirmed by us). The figures for T. equiperdium are almost identical to T. evansi figures.

The specificity of the action of the compound against particular strains of trypanosomes is well shown but the reason is not clearly understood.

35. The effect of germination, autoclaving and heat processing on the digestibility and the biological value of the Bean Proteins of Phaseolus Aureus Roxb and Cicer Arietinum L.

P. B. Sen *and* K. Mukherjee, Physiology Department,
University College of Science, Calcutta.

These beans are consumed in many forms. Their digestibility and the biological value of their proteins have been investigated. It has been observed that there is no appreciable diminution of digestibility of Cicer arietinum and Phaseolus aureus protein during heat treatment, germination and autoclaving. The biological value of Cicer arietinum protein, definitely improves on heat treatment and germination but that of Phaseolus aureus protein is adversely affected by these procedures. Moderate autoclaving only increases the biological value of Cicer arietinum to a slight extent but Phaseolus aureus protein suffers a diminution in the biological value.

36. A study on the Toxycity and Cardiotonic Effect of a series of Pheynl Biguanide Compounds Synthetically prepared.

P. Ray *and* N. N. Das, Physiology Department University
College of Science, Calcutta.

A series of Phenyl-biguanide compounds which were synthetically prepared were tested for the toxicity on paramecium and other animals and it was found that sulphates of the compound are more toxic than hydrochlorides. One of the compounds p-dydroxy phenyl-biguanide hydrochloride has a great stimulating action on heart. It was found that a perfused heart beating feebly can be revived and kept going for a much longer period under the effect of the drug. A study of the subject is in progress.

37. Assay of Commercial Samples of Crystalline Penicillin.

J. N. Basu *and* J. C. Pal: Calcutta.

Chemical methods of Sheehan *et al* (J. C. Sheehan, W. J. Mader, and D. J. Cram. J. Amer. Chem. Soc. 1946, **68,** 2407) and of Alicino (J. F. Alicino. Ind. Eng. Chem., Anal. Edu. 1946, **18,** 619) were tried on a munber of commercial Samples of Crystalline Penicillin G. and the results obtained were comparable with those obtained by the usual "Cup & Plate method" of microbiolygical assay, as modified by Heatley (N. G. Heatley, Biochem. Jour. 1944, Vol. 38, No. 1, p. 61). Of the two chemical methods, that of Sheehan ***etal*** utilising the formation of N-ethylpiperidine Salt of Penicillin G is recommended to be adopted for the assav of commercial Penicillins, as this method gives the best chance of anomalous conclusions being drawn on account of interference with other products.

38. Haematological picture of normal adult people of both sexes in Orissa.

S. M. Banerjee, S. Tej and J. Senapati,
Orissa Medical College, Cuttack.

Values regarding R.B.C. total count, W.B.C. total and differential count, M.C.H., M.C.V., blood Sedimentation rate, etc., have been obtained from 50 apparently healthy college students of both sexes. Some of the values show wide variations from normal for example high B.S.R., macrocytic anaemia and Eisophilia without symptoms. It is proposed to extend the work to all age groups of sufficient number of cases so as to enable to establish normal values and to ascertain causes of gross abnormalities.

SECTION OF PSYCHOLOGY & EDUCATIONAL SCIENCE

President:—PROF. T. K. N. MENON, M.ED.

I. GENERAL AND EXPERIMENTAL PSYCHOLOGY.

N. S. N. Sastry, Bangalore.

1. Honesty Index.

The necessity of depending upon the honesty of testees, in the several psychological tests, makes it imperative to have a dependable measure of the testee's honesty: The paper desribes an attempt to measure honesty with the help of two honesty tests.

The index and the coefficient of correlation has been worked out on the basis of of the scores in the two tests. The index of honesty is indicated by the formula;

$$\text{H. I.} = \frac{s}{n} \times \frac{r}{x}$$

where s = Total score that a testee gets,

n = Total number of cases,

r = No. of successful performances,

x = No. of crucial cases.

2. Sex Differences in Inductive Reasoning During Early Adolescence.

M. M. SHUKLA, Baroda.

An investigation to study inductive reasoning in children of ages 12, 13 and 14 was carried out in the town of Maldon in the county of Essex in England. A group test of inductive reasoning was constructed for the purpose and was administered to children of both the sexes in Secondary Modern and Grammar Schools in the town.

On comparing the performance of boys with that of girls, the latter were found to be superior at all the three age-levels under investigation. The differences between the mean performances of boys and girls at the ages 12 and 13 were not found statistically significant. At the age of 14, however, the difference between the mean scores of boys and girls was found to be statistically significant at 5 per cent level. When the mean scores of boys and girls for the entire age-range (12-14) were compared, the gain in favour of the girls was again found statistically significant at 5 per cent level.

The results obtained in this investigation are thus in harmony with the general findings of Burt and other workers in the field of intelligence testing, the intellectual superiority of girls over boys during early adolescence.

3. "The Reliability of Personality Questionnaires".

S. JALOTA, Jamshedpur.

The questionnaire method can magnify the field of exploration to an almost unlimited extent. The limits being set by the horizons of literacy. "Gallup-polls" and 'Straw surveys are being conducted in India nowadays so the importance of our problem is only a reflection of current interest.

There are two criteria of the reliability of a test, the internal and the external. I have written about the former elsewhere. Here I discuss the latter that is comparison with the actual observations during a re-test.

Out of about 1000 candidates tested for selection, 20 were cases of re-test. In one personality questionnaire there were six questions; two of which referred to the subjective or emotional aspects, the rest referred to the objective situation or habitual modes of knowing and acting. The answers in the retest, were scored as 'Substantially the same' or as 'different'. The frequency of the similar answers were as follows:—

No. of similar answers	1	2	3	4	5	6
Frequency	3	3	4	5	4	1

Further, the similar answers for (*a*) the total = 53.66%

(*b*) objective questions = 66.25%

(*c*) subjective questions = 37.5%

(d) either of the two subjective questions = 10%

***Results*:**

(*a*) The reliability of personality questionnaires is generally low.

(*b*) it depends upon the proportion of questions that probe the subjective or objective or objective aspects of the candidate.

(*c*) the direct subjective questions usually do not get reliable answers.

4. The Value of Differentiating between the Concepts of Growth and Development as applied to Psychology and Education.

(Miss) J. F. Forester, Madras.

Although "growth" and "development" are frequently used to denote different aspects of change in the processes of physical maturation, they have been for the most part used interchangably in psychology.

The distinction in the physical aspects is between increase in size and increase in complexity.

The thesis of this paper is that there is value in carrying over the distinction in these concepts to psychology, "growth" standing for simple increase, practice and consolidation, and "development" standing for the emergence of something new, the co-ordination of existing elements into new patterns, a new relevant context etc.

Growth and development, although distinguishable, are intimately interrelated and can be observed both in phylogenetic responses and in the processes of learning which are the basis of education. Growth lays the foundation for further development, and development provides the context within which growth must work. Growth satisfies the need for security, development the need for adventure.

Discussion of various problems of interrelatedness, *e.g.*, rates of growth and development and their influence on each other. The concept of maturation and 'readiness' for development or learning; its importance in curriculum planning in relation to the optimum time to introduce certain subjects and topics.

5. *Mental Survey of a Village.*

C. M. Bhatia, Allahabad.

It is a report of individual mental testing, with the help of a Battery of Performance Tests of Intelligence of all the illiterate boys of a typical U.P., village. The final table of the mental ages and the I.Q's. of the boys are given, and some particular cases are discussed from the point of view of educational guidance. The Battery of Performance Tests, which contains as sub-tests,

(i) A adaptation of Koh's Block Design Test.
(ii) A adaptation of Passalong Test.
(iii) A specially constructed Pattern Drawing Test.
(iv) A specially constructed Immediate Memory Test.

& (v) A specially constructed Picture constructions Test has been constructed and standardised by the author for literate and illiterate boys between the ages of 11 to 16 years.

6. The Construction of a group attainment test of Hindi.

(Mrs.) Kamla Mehrotra, Allahabad.

The construction of the test has been taken up in view of the growing importance of Hindi which is being introduced throughout the Province as a compulsory language upto the Higher Secondary Stage.

On the basis of an analysis of the various objectives of the teaching of language, items testing the following have meen included in the test:-

(1) Comprehension of written matter in prose and verse.
(2) Vocabulary.
(3) Knowledge of Grammar.
(4) Spelling of words.
(5) Common idioms, phrases and proverbs.
(6) Appreciation in poetry and
(7) Composition.

For the initial try-out two forms of 100 questions each have been prepared. After the try-out, about half the present total number of questions will be selected according to their difficulty value. Thus the final test will have about 100 questions covering the above aspects of linguistic ability.

The prose passages and other materials included in the test are from the environment of the testees. The poems of well known poets have been selected both from the ancient and the modern period.

7. Group Verbal Test of Attainment in History for class IX.

(Mrs.) Kirti Devi Seth, Allahabad.

The existing examinations being subjective are liable to errors of personal judgment in measuring the achievement of the pupils in various subjects. Here an effort is made to devise an accurate objective achievement test to do away with this main defect. The criteria taken into consideration in order to make the test an accurate measuring instrument are, firstly its validity it must measure what it aims at measuring; secondly, its reliability the consistency of the test and thirdly, its usability, the test must be usable.

A detailed study of the curriculum of history for class IX is done before the construction of the test. The minimum period covered in almost every school in class IX has been taken up as the contents of the syllabus. The information as far as class VIII on the subject has been asked only as a connecting link and not as the main subject. Further, such items as present a complete view of historical facts have been selected.

The questions have been so framed as to call-into play such psychological factors as memory, reasoning, imagination and visual imagery.

For the try out purpose the test will be administered on about 150 subjects in four institutions. The two forms of the test will be administered in an interval of seven days.

Then the validity of the test and the difficulty value of items shall be found out and on this basis the items will be selected for the final draft.

8. An analysis of the returns of a specially prepared personality inventory from one thousand educated Bengalee youths.

NILADRIPATI BOSE and GORACHAND KUNDU, Calcutta.

A personality inventory of 45 questions was used in connection with the selection tests for candidates applying for admission in the Calcutta Medical College and the Campbell Medical College, 1948. The present paper is based on the analysis of the records of one thousand applicants who were all Bengalee boys having passed the Intermediate Examination in Science. The analysis shows interesting findings about temperamental qualities.

9. A Preliminary Report on construction of an Attainment Test in General Science for class VIII of U.P. Schools.

GURU MAUJ PRAKASH, Allahabad.

For constructing the test, first the main objectives of the teaching of General Science were noted. The main ones are the acquisition of:—scientific facts and vocabulary; the ability to apply the general scientific principles to the facts and phenomena of the laboratory and nature; skill in manipulating the apparatus used in scientific experimentation; and scientific observation and attitudes of impartiality and critical thinking. Of these the attitudes and the manipulative skill could not be included in the test for obvious reasons. Emphasis is laid on the testing of the ability to apply the facts and principles of science and not on memoritor learning.

The test consists of two forms with 150 items each. They cover the prescribed course. Each form has five sections as follows:-

Section I. Alternate response items (25)

Section II. Multiple choice items (30)
These questions involve application of principles and grasp of concepts.

Section III. Question on diagrams (45)
These are based on mechanical ingenuity knowledge of appratus and experiments and structure of complex machinary and organism.

Section IV. Completion and simple recall items (30)

Section V. Matching items (20)

Frequent use of diagrams has been made, and facts and phenomena from children's environment are included.

10. "Studying Social Relationships Among Children—A Survey of Techniques and an Illustrative study of Inter-personal Relations in a Group of about fourteen year old Boys."

J. K. SHUKLA, Baroda.

The recent findings of social research have emphasised the importance of studying the general development of the social behaviour of children with particular reference to the study of inter-personal relations, social acceptance and rejection. The present paper is intended to give a brief explanation of the term 'social relationship' and the related concepts used in present-day psychology and emphasises the need of investigating the complex process of social maturation of school children.

For this purpose a general review of some of the methods employed in various studies is undertaken. Diaries, and Personal records, Time-sampling, Verbal-choice, Paired comparison, and Experimental techniques etc., are considered and a detailed account of the present-day Sociometric method as used by Moreno is given. Explanation is offered of the typical Sociometric test, its characteristics, and of the techniques for graphical presentation of sociometric data, as also of the relevant statistical considerations involved. The value to education of the Sociometric method is then briefly considered.

Finally an investigation undertaken to demonstrate the use of this technique for analysing the inter-personal relationships in a class of about fourteen year old boys is reported and suggestions are offered for possible scope of research in this direction. A short bibliography is given at the end.

11. The singnificance of *analogy items* in the 'omnibus' type of group intelligence tests.

S. K. BOSE, Calcutta.

The correlation of the scores on the analogy items only with those on the whole set of items in the verbal intelligence tests used by the S. P. Directorate during World War II, was worked out by the present writer in collaboration with his colleague in the War Department, Dr. K. G. Rama Rao. One thousand records were examined at that time. With the assistance of a postgraduate students, Sreemati Maya Guha, the records of one thousand candidates seeking admission in the Calcutta Medical College have now been examined. They were given a specially constructed test of intelligence comprising sixty items of which eleven were analogy ones. High positive correlation has been obtained.

The paper also presents a theoretical discussion on the importance of the capacity for seeing analogous relationship as a constituent of what is known as intelligence.

12. Perseverative Tendency in Mental Set.

K. C. MUKHERJI, and A. ROY, Calcutta.

The effects of perseverative tendency in different mental sets are shown in this paper.

13. "The Concept of 'Set' in Modern Psychology".

DAMODAR MISRA, Patna.

The concepts of "Set" has been the basic notion in Modern Dynamic Psychology. The theoretical position of Modern Psychology is no longer mechanistic. The more recent trend of development is towards treating Psychology as a "Science of Behaviour" and such a Science is not necessarily mechanistic or Behaviouristic.

The attempt here has been to show by integrating the results of studies that determination of behaviour by the 'intervening variables' is an established fact and that a "Science of Behaviour" cannot do without the motion of the "Set" or the "Einstellung". The "Einstellung" faeilitates and also inhibits behaviour.

The Historical Development of this concept has been traced and certain experimental results have been cited. The new development in psyochologising that it is not only the fundamental prepotent biological needs which constitute the drives, habits and modes of reaction acquired may also have equally driving force. Woodworth's doctrine embodied in his "Mechanisms become drives" and Allport's concept of "Functional Autonomy" are incorporated.

The final position taken is that with these new developments Psychology, as a Science, can no longer afford to be mechanistic and that a psychological consideration of behaviour will be incomplete and inadequate if it does not include an account of these "intervening variables".

14. A note upon the Statistical Aspects of the Omnibus-type Verbal Test No. GIT-013.

S. Jalota, Jamshedpur.

The test contains 92 items, consisting of Number-Series, Analogies, Vocabulary (Synonyms-antonyms), Instruction, Best Answers, Classification and Verbal Reasoning or Sentence completion). The Instructions and some numerical items were given in the *inventive* form, while all the rest were put in the *Selective* form.

The following results were obtained from 237 candidates who appeared during December, 1947 to July, 1948 for Selection Tests in the Tata Iron & Steel Co. Ltd., Jamshedpur.

Mean = 52.82 S. D. = 17.64

Range = 8.87 Relative skewness or B_1 = —.305

Relative Kurtossis or B_2 = + 2.19

The coefficient of Reliability as measured by correlating the correct scores of the ODD and EVEN items is +.927. With the application of the Spearman-Brown prophecy formula the figure of reliability goes up to +.962 with a standard Error of. 0061.

15. Construction of a Group-Attaiment-Test in English.

Kanti Chandra Pandey, Allahabad.

A group test is devised for measuring the attainment in English for the boys and girls-reading in 8th class in the schools of U. P. The criteria for the choice of items in the test are those objectives of teaching English which lend themselves to objective testing. In general, they test the ability to read and understand English and to detect common faults in the written language; the acquisition of familiarity with certain common rules of grammar and punctuation; and the acquisition of proper vocabulary. The following classes of questions have been included:—

1. Reading and comprehension of prose and verse.
2. Vocabulary.
3. Appropriate words and phrases.
4. Synonyms and antonyms.

5. Idioms and phrases.
6. Detecting faults in words and sentences.
7. Questions on grammar.
8. Questions on punctuation.
9. Questions on spelling.
10. Questions on rhythm.
11. Questions on the use of articles.

The test-techniques mostly employed are completion and multiple choice.

16. *A Critical Study of Kohs Block Design Test.*

D. D. Tewari, Allahabad.

The main problem studied is the claim of Kohs with regard to Blocks Design Test for discrimination of higher levels of intelligence. Kohs makes a very high claim in this respect. In order to arrive at some tentative conclusions, the Allahabad Intelligence Tests for 11 by Dr. Sohan Lal was also administered to the subjects.

The results of the two tests are discussed in full and in the end conclusions are stated with regard to the main problem.

Method adopted for administering the test:

The coloured cubes are shown to the subject and it is explained that all of them are identically coloured. It is fully ascertained that the subject can identify each colour separately. Then the subject is told that with these blocks he has to prepare certain designs which would be presented to him. Then a trial design is presented by the experimenter. The subject is not told the time limits in order to avoid excitement. The time however is noted by the experimenter. Although in administering and scoring the test the counting of moves is also important, but as it involves a somewhat complicated task of combining two variables, it has been abandoned and time alone is taken account of in determining success of failure.

17. Mental Survey of two Villages in U.P.

Guru Mauj Prakash, Allahabad.

A survey of Intelligence of illiterate boys between 11 to 16 years in age was carried out. The villages selected for this purpose were Biashanpur Bindwallia and Mathauli both lying in Tehsil Padrauna of District Deoria in the United Provinces. Bhatia's Battery of Performance Test was employed.

The investigation revealed that the illiterate boys in these villages had I. Qs ranging from 55 to 110, two having capacity to benefit from higher studies and six by education upto Senior Basic stage. One case of mental defficiency was detected.

Inter-correlations between the tests of the Battery for the 34 cases were found to range from .35 to .67. Three main problems were usually met with in village testing *viz.*, the problem of ascertaining the age of the boys, the presence of curious villagers round the place of testing, and the suspicious attitude of the villagers towards the test.

18. A Psychological Study of the Physical Efficiency Tests.

R. N. Tripathi, Allahabad.

(1) The nature and the fundamentals of these tests as prepared by the Council of Physical Education, U. P. for being prescribed in the Basic and the Secondary Schools of U.P.
(2) The aim and objectives behind these Physical Testings.
(3) The problem of their standardisation and adaptability.
(4) The problem of the suitability of these tests in relation to the special and peculiar Indian conditions (Analysed and discussed in fuller details.)

19. Construction of an "Intellegence Test" for 12 plus in Urdu.

A. W. B. QADRI, Allahabad.

Two sets of questions are framed. Each contains 150 questions and classification is the same in both the sets. They contain the questions under the following heads:—(1) Direction Test (2) Classification (3) Analogies (4) Same and opposite (5) Mental Arithmetic (6) Code reading (7) Proverbs (8) Mixed sentences (9) Best answers (10) Essentials.

These tests are administered to the students of the requisite age in the Anglo-Hindustani Institution. It is taken into consideration that the initial try-out is given to a fully representative group of students. With this object in view the students from different types of institutions-such as Govt. institutions, aided instititions, institutions run by the Municipal Board (that is, vernacular Middle School of yesterday, are taken. The districts selected for try-out purposes are Allahabad and Budaun (a district in Rohail-Khan division). These places are selected not simply on the grounds of convenience but for being 'models' in certain respects. Allahabad being the centre of the provincial educational activity, is certainly ahead of other districts in the field of education. Badaun is a seat of learing so far as Urdu is concerned and the students are believed to posses a better knowledge of the language than those in the other districts. But being a small district has not attracted the full attention of the Government, and the education is not being imparted in a perfect manner. In this way the two districts present extremes to a great extent.

After drawing out the 'difficulty error', 50% of the questions are dropped and the final test contains 150 questions with a time limit of 45 minutes.

20. The Construction of a Verbal Group Intelligence Test for Boys and Girls of 12 years in the Schools of the United Provinces.

GURU MAUJ PRAKASH, Allahabad.

As a step towards the satisfaction of the need of proper and sufficient 'Tools for Educational Research' the problem has been taken up. The Test contains two forms of about 150 questions each. The items selected are multiple choice and complection types of classification, analysis, essentials, number series, substitution, space relations, incomplete sentences, obeying directions, anologies, reasoning and absurdities. The criterion for choice of items was their correlation with. Alphabet matrices have been used in obeying direction items. In anology items a simple verval method has been used and not the mathematical notation of proportionality. Special care has been taken to make the language easy and the contents interesting.

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After a try-out in schools of Allahabad the final test will contain two equivalent forms with 100 questions each.

II. ABNORMAL PSYCHOLOGY

21. Mental Cases under Family Care.

K. D. GHOSE, Calcutta.

This is an experimental study of four mental cases that did not respond to treatment in Mental Hospitals and were put under the supervision of sympathetic families—one under that of the patient's own family and the other three in foster homes. This technique of placing patients in carefully selected homes has yielded very satisfactory results as in the Unted Staes of America, Canada and Switzerland. Mental experts have now turned to this new technique. The general mode of treatment and supervision in selected homes. Sympathetic handling and gradual adjustment to life in general. Patients gradually feeling an inclination for simple types of work and becoming fairly useful men and women in society. Difficulties, the question of expenses and the great reluctance of Indian families to have patients.

22. New Trends in Psycho-analysis: A Critique of Freud.

M. M. SHUKLA, Baroda.

Recent developments in psychology do not lend support to some of the Freudian assumptions re: the origin and treatment of neuroses. Though some of the doctrines of Freud, *e.g.*, the strict determination of psychic processes, unconscious motivation, etc. seem to have been fairly established, his teachings re: the nature of man and society are positively misleading.

An attempt is made in this paper to show how Freud's conception of human nature is essentially a reflection of the XIX century philosophy, economics, anthropology, neurology, etc., and how it shares their limitations. Freud's exclusively biological orientation led him to neglect the cultural factors in the causation of neuroses, and to mistake the peculiar drives of modern man as his original nature. It also led him to underestimate the therapeutic possibilities of a properly controlled environment, both mental and material.

Finally, a new orientation of psycho-analysis in the light of recent findings of psychology is presented, and the new possibilities of treatment are suggested.

23. Study of a Case of dual-Personality.

UDAI BHANU, Indore.

A women of 32 was attacked by a ghost. She was kept under observation for six months.

During the attack she breathed heavily and quickly, nodded her head, did not love her child, experienced illusions, and behaved in every way as if her own personality was totally depressed.

The ghost showed her name. She promised several times to go away and leave the patient alone but her promise was never fulfilled.

The following conclusions are drawn:-

I. Some persons develop a mental state which depresses the personality of the self.

II. From the data collected it is difficult to accept the existence of another entity as true.

III. The fixation of the ghost was so deep in her mind that she (ghost) was regarded as the only cause of all the physical ailments from which she suffered from time to time. In other words we can say that the fixation of an idea affects the finding of causes.

IV. There is a state of fixation which cannot be removed by analysis, distraction, fear, pain and devotion.

III. EDUCATIONAL PSYCHOLOGY.

24. Perseveration and Teaching Ability.

T. K. N. MENON and S. C. PARIKH, Baroda.

The present inquiry was instituted to find out whether perseveration helps, hinders or has no relation to teaching ability, and if there is any functional relationship between the two, to find out to what extent the relationship exists:

(*a*) Preliminary investigation: The subjects chosen were 43 graduate teachers undergoing professional training. The subjects were given the 'IT' test, their perseveration scores were determined the coefficients of correlation between

(*i*) perseveration scores and internal marks and

(*ii*) perseveration scores and marks given by external examiners were determined. The analysis of the data resulted in the following conclusions.

(1) Individuals vary considerably with regard to 'perseveration', some are high perseverators, some are moderately high perseverators, some are moderately low perseverators, some are low perseverators.

(2) There is a negative correlation between "perseveration" and 'teaching ability' as judged by 'internal marking' or 'assessment by external examiners'.

(*b*) Final investigation: The subjects chosen were 70 graduate teachers and 20 undergraduate teachers undergoing professional training. The subjects were given

(*i*) the 'I.T' test

(*ii*) Reverse stroke test

(*iii*) Alphabets test

(*iv*) Aitches test.

The perseveration scores were determined and these were compared with the valuation of teaching ability given by a Committee of Masters of Methods. The results of the final experiment confirmed the conclusions of the pre preliminary one.

25. Assessment of Interest in Medical Science among Applicants for Admission to the Medical Colleges of Calcutta.

GORACHAND KUNDU, Calcutta.

A short questionnaire enquiring why the applicant is keen to join the Medical Colleges, what profession he will choose if he fail to get into medical line, etc., was given to about 1250 applicants. They were also required to show the extent of their commonplace knowledge of medicine and hygiene by answering 16 questions on the subject. The answers of 1000 applicants have been scrutinised.

26. A Study of Errors in English.

MISS. SUSHILA VARMA, Allahabad.

The aim of the investigation is to find out the common errors of children and to examine their nature and their psychological causes. The second and most important aim is to devise some methods based on sound principles of psychology, to root out such errors in English.

The exercise books of children were collected from different schools and different classes in each school. The exercise books of children from class third to tenth were examined.

An attempt has been made to compare errors of children in Indian schools with those of English schools. These errors have been classified into significant types and remedial measures have been suggested based on the phychological analysis of the types of errors.

27. A Psychological Study of the Working of the Basic Scheme in Allahabad University 1947-48.

S. P. S. CHAUHAN, Allahabad.

The working of the scheme of Basic National Education in 25 Basic schools (rural) in Allahabad District was studied. On examination it was found that the children who were taught in a basic way, appeared to possess intelligent thinking and a broader outlook.

This paper deals with the psychological study of the working of the scheme and goes to prove that the Basic Education is based on a sound psychological foundation. Children overflow with instinctive energy and this education provides outlets, through crafts, which are of great value to the individual and society. Manual work too helps in gratifying the creative desires which direcetly helps the growth of individuality. Transfer of Training is more facilitated when a child learns in a basic way rather than through Books. A few constructive suggestions have been added to make the Basic Scheme more perfect.

28. Reading Interests and Habits of Girls.

(MISS.) M. GHOSH, Allahabad.

The object of this investigation is to find out with the help of questionnaire, what kind of books beside the text books (prescribed) in Hindi, they read at home, what kind of books are available to them for their outside reading, either from the School library or their parents purchase for their Supplementary reading. The attempt is to find out their likes and dislikes in reading the kinds of books they are interested to read, the type of contents which interest them most.

While giving the questionnaire, to be answered by the girls, the girls were told that this is not an examination but an enquiry, which help the teachers, heads of institutions, parents and guardians in choosing better reading material for them, and also to help the authorised publishers know, what the girls like to read, what they do not like to read.

The questionnaire is in Hindi, and consists of eighteen questions, some of them including parts.

The questionnaire is meant for IX and X classes of four secondary institutions (girls) at Allahabad. The total number of girls tested is about 200.

The answers to questions have been analysed and conclusions drawn.

29. A study of Reasons for the Dismissal of Teachers in Secondary School.

L. J. BHATT, Baroda.

Teaching profession looks for certain desirable traits in the teachers who are employed. The absence of some of these traits give rise to conflict between the employers and the employees, and subsequent dismissal of the teachers. The reasons for such dismissals were elicited from the employers, classified into statements (Table I and Table II) and the following conclusions arrived at: (1) those dismissed lacked qualities of leadership, (2) those dismissed displayed unbecoming conduct, (2) they failed to co-operate, (4) they were not able to adjust, (5) they were not industrious and (6) some mismanaged financial side of the work. etc.

30. A Study of Teachers as depicted by Charles Dickens.

L. J. BHATT, Baroda.

Teaching efficiency does not readily submit to analysis. The researches relating to qualities essential for success in teaching have among others worked upon: (1) compilation of pupils' opinion, (2) summarizing of expert opinions. The practical school-men and others interested in the education of their children are consulted as experts.

Psychologists have made a study of children in Charles Dickens. There is a scope for a similar study re: Teachers in Charles Dickens. His novels like Nicholas Nickleby, Old Curiosity Shop, David Copperfield and others give pictures of teachers Dickens liked most and teachers Dickens liked least. The paper gives an analysis of Dickens' opinion which would prove useful to all engaged on the problem of measurement of teaching efficiency.

31. A Study of Adult Education in Allahabad.

MAJID HUSAIN SIDDIQI, Allahabad.

I had two considerations in my mind when I chose "Adult Education in Allahabad" as the topic of my paper. The first was that future of India is linked up with the progress of adult education.

The second was that Allahabad, being the centre of all educational activities, will serve as a model to the work done in the field of adult education.

I handled this problem by emphasising the need of adult education in independent India from the political, social, educational and philosophical point of view. Then a brief review of the work done in this field in U. P. was made to serve as a background to the actual study of adult education in Allahabad.

In studying the various institutions and schools for adults I took special care to examine their organisation curriculum and the method of teaching. My main task is to apply the Psychological principles to the adult education and to give some constructive suggestions.

32. An Inquiry into the Performance of Graduates Under Training.

L. J. BHATT, & A. S. PATEL, Baroda.

It is apparent that intensive study of curriculum problems directly related to the education of teachers should be taken up seriously on a nation-wide scale. Usually the B.T., L.T., or B.Ed. Courses cover two aspects of a teacher's education—the practical professional training and the theoretical professional training. The paper under report makes a study of ten groups of Graduates who appeared for the B.T. degree examination in the preceding ten years from the year 1939 owwards. Their achivement in terms of University marks in theory and practice is analysed and coefficients of correlation are worked out to establish the influence of theory of education on the practical teaching ability.

It is clear that a knowledge of theory of education considerably helps a teacher in his practical class-room teaching, as càn be noted from the positive coefficients of correlation. Reasons for those cases where correlations are not comparatively significant are also studied in the paper.

33. A study into the General Physical Standard of Students entering Allahabad University 1947-48.

JAGDISH RAM MEHTA, Allahabad.

The recent findings of physiological psychologits have thrown much light upon body mind relationship. The educational implications of this relationship has however now been grasped. In our inquiry we have two things in view, firstly, to gauge physical standard of health already attained by our young men entering Allahabad University and secondly to find how far our health medical service and Physical Department work in coordination and close co-operation as to prove effictively helpful for the scholars to achieve desirable health standard.

The basis of our enquiry is a Medical Health Report 1947-48, comprising 697 cases who duly medically tested by our medical officer. The necessary data in (1) Height (2) weight (3) Chest measurement (4) regarding vision (5) General diseases was gathered from the Medical Report. We then come to the following finding by statistical calculation.

	Gereral Scholars.	Hindus.	Muslims.	Sikhs.
	No. 697	600	55	42
(*a*) Mean Height inches.	66.24	66.03	66.89	66.21
(*b*) Standard Devitation.	2.727	2.748	2.57	2.602
(*b*) Mean Weight, in pounds.	130.54	120.24	116.06	131.98
(*b*) S. D.	16.211	19.495	17.91	14.24.
(*a*) Mean Chest.	33.186	32.87	32.87	33.74.
(*b*) S. D.	2.376	2.204	2.19	2.058.

The above statistical work has been graphically illustrated and coefficiets of correlation between height and weight H have been established which are as followsff—

	Hindus.	Muslimas	Sikhs.
Coefficient of correlation H|W.	0.553	0.36	0.297.
Probable Error.	0.017	0.079	0.093.

34. Physical Education and National Health.

VED PARKASH BANSAL, Allahabad.

The conditions of modern civilization, with its crowded localities, confined places and sedentary occupations the increasing need for study and mental application, the many social and psychological difficulties of every day life, the war and its after-effects, shortage of food grains, the unwholesome and unnutritious food, regular and steady elimination of ghee and milk and instead Dalda and Kotogem ever coming strong upon our diet, have all restricted opportunities for natural physical growth. However, there is one panacea for all these evils and that is physical education. It is therefore necessary to evolve a nation-wide programme of physical education, which will be physically wholesome mentally stimulating and socially sound.

Now that India has achieved independence she may have to defend herself not in the distant future but perhaps in the immediate present and it is the might of the Indian

Union as manifested in her capacity to fight in the battle-field that will determine India's place in the comity of nations. For that India has to raise and reorganize her forces. Young and healthy citizens are needed both in the military and in the homes and yet all this is possible only through an organized programme of physical education.

35. *Working of the Montessori System of Education in India.*

(MRS.) B. DE, Allahabad.

Revolution in political, social and economic field accompanied by inventions and achievements of Science created a new attitude in all aspects of life and hence a reaction followed against the old theory and practice of education which resulted in efforts individual or otherwise, particularly in Germany, Italy and America. This reaction got support and strength from psychology and experimental work. The efforts of Maria Montessori were an event in this general revolutionary set-up. The central feature of her method which originally had medical importance, is sense-training and development of personality through playway and with the help of her didactic materials. It is a clear and remarkable advance in the field of education. But in India old education still persists, and the efforts for new education suffer from a very big gap, *i.e.*, there is no provision in any scheme for educating children of pre-school age. It would be my effort to indicate how the Montessori method has been worked out in India specialy in U.P. and how improvements can be effected in this field according to Indian conditions.

IV. VOCATIONAL PSYCHOLOGY.

36. A report on the testing of intellingence and special abilities of a group of Railway workers.

(MISS.) USHA BHATTACHARYYA, Calcutta.

A group of one hundred unskilled and semi-skilled Railway workers were examined in the Chitpore and Barrachpore yards near Calcutta. Non-verbal intelligence tests and mechanical ability tests were given and every individual was interviewed to find out how far placement was made in accordance with the qualities as indicated by the psychological examination.

37. Fatigue—Tests in Industry—A Report.

KALI PRASAD and HARI SHANKER DUBEY, Lucknow.

The present paper describes an investigation into 'Industrial Fatigue' in a textile mill. It is proposed to see if it is possible to use relevant psychological tests to confirm the findings of output-data.

The investigation has been carried out in relation to two sets of data:

1. The hourly output records arranged to show variations in rate of work for consecutive days of the week and for a composite working day.

2. The results of steadiness and disc-dotting (a modified version of Mc Dougall's Three-hole disc-dotting test) tests administered to a sample of workers in the factory situation at three different stages of the day *i.e.*, before the work, in the interval and after the work.

The experiment shows that:

1. There is a progressive deterioration in work in all the shifts and sections. The curve of night work shows steeper decline in the second spell.

2. The deterioration in output is accompanied by a progressive depression and unpleasant 'feeling tone' among the workers.

3. Corresponding to the above changed there is a gradual weakening of attentive capacity, muscular unsteadiness and visual-motor incoordination.

38. An Experiment in the Introduction of the Rest Periods in the Working Spells and Their Influence in the Productive Capicity of the Workers in the Weaving Factory and Their Health.

Devendranath L. Amin, Mysore.

The paper reports the influence of the rest period in the working spells on the health and the efficiency of the workers. The study is intensive and the experiment is extended over approximately a period of six months, (Nov. 1947 to May 1948) with eight workers. The result shows that when the rest pause of seven minutes at 9-30 A.M. in the morning spell and another rest pause of fifteen minutes at 2. P.M. in the afternoon spell (When the factory is working between 7. A.M. and 3-45 P.M. with an interval of 45 minutes at 11 A.M. are administered, they are conducive to the health and efficiency of the workers. It also describes the method of determining the nature, the location, and the duration of the rest periods. The statistical results show that though there was a loss of 3.5% in time in eight hours of work, still an increase in efficiency by 2.5% on the whole was noted as compared with the previous out-put records. The rest pauses also indicated favourable variation in absenteeism, sickness records, etc. However it is desirable to carry on such an experiment in different factories differing in the nature of work and showing variations in the climatic conditions etc. to study the effects of rest periods on accidents, labour turn-over, effiiciency and absenteeism and further to analyse whether the influence of the rest, peside persist even after they become routine in nature.

39. Injury to the Mind in Industry.

N. S. N. Sastry, Bangalore.

Occupational hazards are many and they naturally call for immediate remedy. Many such hazards are usually connected with the danger of physical injury. There is another kind of hazard which is equally, if not more, dangerous. This is mental injury. An individual who is thus injured might develop a neurosis. The neurosis might be developed before the injury actually takes place, or during injury, or after injury. At the present time many methods are employed to meet these situations and often to prevent such occurences. But there is an urgent need for more effective measures and methods to be employed. Sometimes, injury to the mind can cause more danger than injury to the body.

40. A Short Survey of the Intelligence, Attitude and home-life of a group of women unskilled labourers.

(*Misses*) Bani Sarkar, Maya Guha and Uma Bhattacharya, Calcutta.

With the kind permission of the TISCO authorities the survey was undertaken in May and June, 1948. One hundred and five women workers of the Tata Works at Jamshedpur were given the tests and also interviewed. Homes of some of them were visited. Attempt has been made to find the relation, if any, between intelligence and attitudes towards work and life in general.

41. Prediction of Accident Proneness amongst Industrial Workers by Psychological Tests.

Asim Kumar Pal, Calcutta.

Facilities were kindly provided by the Chief Psychologist of TISCO to study the incidence and factors of accident among the workers in the Sheet Mill at Jamshedpur. 150 workers selected for the purpose of investigation were wiven a battery of intelligence tests as also other psychological tests. Intercorrelation of the tests as well as correlation of frequencies of accidents with the test scores have been worked out. Prediction of accident proneness has been attempted on the basis of test results. A few suggestions regarding remedial measures have been made.

42. Selection of Tram drivers.

(Miss) Kanak Mazumder, Calcutta.

The paper presents a preliminary report on some of the findings of an enquiry into the problem of detecting accident prone tram drivers in Calcutta. The work has been spons red by the Indian Research Fund Association and is being carried out under the guidance of Sri S. K. Bose. Arangements have been made by the Calcutta Tramways Company for testing the driver trainees at their training school at Tollygunj Tram Depot and at the laboratory of psychology, Calcutta University. Every facility has been given by Prof. G. Bose, Head of the department of psychology, for carrying on the testing in the laboratory and outside. The driver-trainees are ranked as 'good', 'doubtful' and 'bad' on the results of psychological tests, and their progress during training period are noted. The career of those appointed by the Company to drive tram cars on the streets of Calcutta are being followed up.

43. An experiment in the selection of the weavers on the basis of their Manual Dexterity and further standarisation of the weaver's tests.

Devendranath L. Amin, M.A. Mysore.

The paper reports how the tests were devised for the measurement of the skill of the weavers in the Weaving Department. The reliability of these tests is determined with 40 workers. The tests are validated by internal certerion of the supervisor's estimates and external creterion of the productive capcity of the workers. The number of workers tested for validating the tests is 40. A follow up was carried out with reference to 15 workers who were employed after testing to check the validity of the tests. The tests are fairly diagnostic and adequate measure of manual dexterity of the weavers.

44. An enquiry into the subjective effect of using ear-plugs by workers and supervisors in noisy places.

By Promadanath Chobey, Calcutta.

The enquiry was conducted in the foundry of the Tata Works at Jamshedpur through the courtsey of the authorities. The workers and their supervisors. 23 in all, were given the ear-plugs for about a fortnight. Their experiences and observation were noted in details. On the whole the use of ear-plugs gave a sense of relief and satisfaction.

V. INTROSPECTIVE ABNORMAL PSYCHOLOGY.

45. 'Resonse Psychology and Gandhijee'.

SRIMANT LAL DAS,

The author has been practising 'Sharanagati' more or less for a quarter of a century now. A short *description* of three 'miracles of Sharanagati' has been given. From Sharanagati he was unconsciously led to the investigation of Response Phenomena' in general.

Three clear ideas, namely the following, dawned on him in due course:— the response of the external world; the response of the inner world; and the Response Psychology.

A brief summary of Response Psychology with special reference to religion, is given followed by choice quotations from the speeches and writings of Gandhiji to show some of the facts of this aspect of mind.

The paper also throws some light on 'the inscrutable ways of the Mahatma.'

VI. CURRICULUM CONSTRUCTION.

46. Music in Basic Education and Psychology.

(MRS.) BANI CHATTERJI, Calcutta.

The spread of basic education among the general illiterate masses in the country is one of the major problems that confront us to-day. For the purpose of the proper conduct, which should incidentally make for better citizenship too, we may well press Psychology into service.

Assuredly fruitful work is being done in Psychology. However, to facilitate and advance it even further, yet other useful sources of information must needs be tapped. Music, it would appear, has much in common with Psychology. As I have pointed out earlier in my articles on the subject (*vide* Proc. Ind. Sc. Congress, 1943 and 1944 and my lecture on "Music and Diversional therapy" delivered on the 31st May, 1945 before the Royal Asiatic Society of Bengal), music and psychology are, in their nature, close allies pursuing a common object, "the attainment of a fully sublimated psyche' free from repressions and inhibitions". Their corner-stone is the human mind; and mind's ascent to self, or spiritual realisation and from this to the yet higher realisation of Divinity, is the common goal and highest aspiration. Music should benefit psychology for the child's natural propensity for music is only too well-known.

In view of all this we may rightly claim that music has, as is unversally recognised in the West, a definite educational value, and a place in the prosecution and promotion of Psychological studies. A team work of Psychology and Music should, therefore, ensure success to the Government of India's plan of "Universal Compulsory Basic Education".

VII GENETIC PSYCHOLOGY

47. Integral Education.

J. M. SEN, Calcutta.

In one sense the responsibility of the educator exceeds that of the physician. The physician, as a rule, has to deal with mental formations already fixed and will find in the already developed individuality of the patient a boundary already established for his activity and also a sort of a security for the patient's independence. The educator, however works on plastic material which is sensitive to every impression and he must observe the duty of not moulding the young mental life according to his own personal ideals but rather according to his dispositions and possibilities inherent in the object.

Children ought to be educated not for the present, but for a possibly improved condition of man in the future, that is in a manner which is adapted to the *idea of humanity* and the whole destiny of man. Parents usually educate their children merely in such a manner that, however, bad the world may be, they may adapt themselves to its present conditions. But they ought to give them an education so much better than this, that a better condition of things may thereby be brought about in future. The view that regards the ego as a fighting force implies that education is a process of acquiring freedom—the freedom of helpful service it may be, but still freedom.

It is obvious that an important part of the work of education must be to make the pupil aware of the nature of his environment. Clearly it is not a matter of mere information. Knowledge according to the nurture theory is valuable for its own sake, when it is valuable at all. But there are many pieces of information about the environment that are in themselves worthless. The knowledge that counts, the knowledge that is power, is not mere acquaintance with facts in their relation to each other. Knowledge must consist of signifiant facts, facts that mean something to the knower, and can be applied by him in some way advantageous to himself or to others. The human being's powers of assimilating knowledge being ludicrously inadequate in view of the vast domain that is available, it is obviously necessary to limit the range. In this process, however, there is danger of introducing scrappiness. On what principle are we to decide what is to be taken and what left out?

So fundamental is this problem that certain educators have set about developing a complete scheme of education the main function of which is to maintain the unity of mental life, and obviate the danger of a completed scheme resulting in a thing of shreds and patches. Those who adopt this ideal of what they call *Integral Education* fall back upon the authority of Descartes and Comte. Since these two philosophers have been driven by their investigations "to proclaim the unity of intelligence and the unity of knowledge, it will be demonstrated that all true instruction must be integral, and that we ought to abstain from dividing and parcelling out what nature has made one and indivisible."

Integral Education should thus be marked by unity of aim or purpose, and should be coherent on all its parts taken together, and each of the parts taken separately. Its ideal would be a knowledge that is universal in its content and universal in its application; that is to say, it should include all knowledge, and this knowledge should be so communicated that it makes the same appeal to all minds. It must be universal in the full sense of that term.

Integral Education is neither an intensive and encyclopaedic culture, nor an artificial selection of minds and a drainage of the intellectual capital of a country, but the methodical development of all the powers or faculties of the human soul by means of the universality of the sciences, classified and arranged in a hierarchy in view of their didactic use.

36th INDIAN SCIENCE CONGRESS, ALLAHABAD, 1949

SECTION OF ENGINEERING AND METALLURGICAL.

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Abtsracts

1. Liquid-Liquid Extraction in a Sieve Plate Tower.

S. K. GHOSH *and* S. K. NANDI, Bangalore.

A study has been made of the extraction rate, hold up and possible throughout in the extraction of Acetone from water by Benzene in a 2″ diameter perforated plate tower. The tower is made of glass tubes fitted with flanges at both ends in between which nine perforated plates were fixed. The extraction rate and hold up are found to be increasing with the increase in the dispersed phase flow rate, but continuous phase flow rate has practically no effect on them. Study of the concentration effect on extraction coefficient 'K_Ba' has shown the effect to be negligible. The H.T.U.$)_{OB}$ is calculated from the extraction coefficient for each reading and is found to be constant with the variation of both phase flow rate. By sampling the liquids above and below each plate an operating line, showing the change in the concentration of Acetone throughout the tower is obtained.

2. Synthesis of 2-Methylphenanthrene.

PASUPATI SEN GUPTA *and* BIDYUT KAMAL BHATTACHARYYA, Jadavpur.

Ethyl m-methyl cyclohenylidine cyanacetate is condensed with benzyl chloride in presence of sodium ethoxide to yield ethyl α-cyano-α-(3-methyl-cyclohex-6-enyl) -β-phenyl propionate which on cyclisation followed by hydrolysis and dehydrogenation furnishes a product identified as 2 methylphenanthrene through its picrate.

2-methylphenanthrene is necessary for our investigation on Friedel-Craft's Reaction (*Science and Culture, 12,* 410, 1947; *114,* 40, 1948). Although there are different methods for its synthesis, the above compound was synthesised according to the method of Ganguli(ibid, *ibid,7,* 319, 1941-42) along the following line.

Ethyl m-methylcyclohexylidene cyanacetate was condensed with benzyl chloride according to the condition of cope etal (*J.Am. Chem. Soe. 60,* 2903, 1938) to yield (I) which on cyclisation by concentrated sulphuric acid followed by hydrolysis and esterification furnished 2-methyl-10-carbomethoxy- 1,2,3,4,9,10,11,12 -octahydrophenanthrene (II, R=Mc). The above ester on hydrolysis gave a gummy acid (II, R=H) which was dehydrogenated by selenium. The product thus obtained furnished a picrate (M.P. 117-18°5, literature records 118-119°, Howarth J.C.S. 1125, 1133, 1932).

3. Interference to Telephone Trunk Lines due to Ripples of Rotary Convertor supplying current to trolley wires of Electric Railways.

H. N. SHRIVASTAVA, New Delhi.

Humming noise is present on the Bombay-Poona trunk lines. An analysis of the noise by the use of resonating circuits showed that the disturbance noise consisted of 300 to 450 cycles per second. Experiments were carried out to find out if D.C. supply for traction contained these interfering frequencies.

The method employed was to connect between the D.C. bus bar and ground wire connected to rails a condenser and high resistance in series. A part of the resistance was tapped and connected to noise analyser the other side of which was connected to a valve voltmeter.

Experiments gave the following results :—

Metro Vicks Rotary Converters	
300 cycles	7.5 volts
1500 „	0.0 volts
English Electric Rotary Converters	
300 cycles	11.0 volts
450 „	1.7 volts
1200 „	1.6 volts
B.T.H. *Rotary Converters*	
300 cycles	25.0 volts
1800 „	1.0 volt.

D.C. voltage varied from 1540 to 1500 from no load to about 1600 amps load.

As more railways are being electrified in the country, it is necessary that Mercury Arc rectifiers should not be obtained without resonating shunts and Rotary Converters should have the minium of harmonics or commutator ripples to prevent interference to communication circuits.

4. Design of an Artifical Network for use with 3-channel carrier on Open Wire System.

H. N. Shrivastava *and* V. Arunachalam, New Delhi.

The necessity for an artificial line network for use with carrier equipment when it is tested in the latoratory or used for demonstration purposes is obvious. Such a line network should have the characteristic impedance and attenuation characteristics of a standard open wire construction. A balanced symmetrical lattice network has been developed and used with two resistance pads. The formula for the propagation constant and the attenuation in decibals for the lattice network has been given. Experimental data have also been given showing the measured loss through the artificial line in decibals and also the loss in a 160 miles of copper trunk in decibals for comparison. The measured loss agrees well with the loss on the open wire line.

5. Localisation of Insulated Break on Communication Lines by Attenuation Tests.

H. N. Shrivastava *and* B. C. Shamamayya, New Delhi.

An insulated break fault on a line is located from the testing office either by bridge tests or by the capacity throw tests. A new method of locating the break by noting the transmission loss to the fault and the difference between the level of the loss reading has been worked out. The theory of the tests has been discussed. The new method has given good results.

6. Periodic Fading of Radio Signals and Vertical Movement of Ionosperic Layers.

S. S. Banerjee, G. C. Mukherjee *and* R. N. Singh, Banaras.

It has been found from our observations on fading of short-wave radio signals that periodic variation of intensity of the signal may occur due to two different reasons. Firstly, it may be caused by interference of two waves, singly and doubly reflected, from the same ionospheric layer, or by two singly reflected waves from two different layers. The second type of periodic fading may be caused by interference of ordinary and extra-ordinary components of the wave due to mageto-ionic splitting. The ionosperic conditions necessary for the above two types of periodic fading are quite distinct from each other. For instance, the first type necessitates high electronic density in the ionospheric layer associated with vertical movement of the layer, whereas the second type is obtained with low electronic density when it is in the state of transition. For the above reasons the second type of periodic fading is generally obtained during the morning and evening hours. Both the above types of periodic fading have been recorded by us and the required conditions of the ionosphere stated above, have been verified from the Ionospheric data supplied by the Research Department, All India Radio, Delhi. It has been further shown that from such observations of periodic fading patterns it is possible to measure the rate of fairly slow vertical movement of the ionospheric layers and also that they may be of great use in predicting the suitability of frequency to be employed for establishing radio communication between two stations.

7. Intensity of Radio Signals in the Neighbourhood of Maximum Usable Frequency.

S. S. BANERJEE *and* R. N. SINGH, Banaras.

The reception of radio signal ceases when the frequency of transmission happens to be higher than the maximum usable frequency between the transmitting and receiving stations or when the electronic density in the ionosphere is lowered till the above condition is reached. It is usually observed however that before the signal actually disappears due to scarcity of electrons in the ionospheric layer, interference occurs between ordinary and extraordinary components of the wave due to magneto-ionic splitting which produces periodic fading of the received signal and its intensity increases prior to its cessation. It is the purpose of the present paper to show that the above enhancement of signal intensity may be attributed to the thickness of ionospheric layer. The increase of intensity however may be caused in two different ways. Firstly, the thickness of the layer gives rise to Pedersen ray which becomes more pronounced towards the end of the signal as the absorption of the wave decreases due to diminution of its path travelled through the inosphere, and consequently, the intensity of signal increases. Secondly, it can be shown that for thick inospheric layer, near the limiting angle of incidence for reception of the wave, the rays incident at an angle slightly lower or higher than this critical angle will be reflected back to the earth at the same distance from the transmitter. Thus there will be a narrow range of angle within which the incident rays at the ionosphere, as radiated from a transmitting aerial, will be reflected back approximately to the same spot on the earth and increase the intensity of received signal.

8. Effect of the Variation of Thickness of Ionospheric Layer on the Magneto-ionic Fading of Radio Signals.

S. S. BANERJEE *and* R. N. SINGH, Banaras.

This paper describes the several types of frequency and amplitude variations of periodic fading patterns of radio signals caused by magneto-ionic splitting. It has been shown that the variation of electronic density in the ionosphere, which is one of the necessary conditions for formation of such fading of signals, is inadequate for explaining all the types of variations observed in fading patterns. The complexity in the nature of fading however may be attributed to the alterations of thickness of the ionospheric layer, which give rise to different path-lengths travelled by the radio waves through the ionosphere and change the shape of fading pattern. Calculations for the above variations of periodic fading have been made for transmissions from Delhi for which observations have been recorded on various short wave lengths. It has been found that comparatively thin ionospheric layers will produce greater amplitude variations in the fading of signal and on such occassions the type of fading may be more complicated due to longer duration of the presence of Pedersen ray, in addition to the two magneto-ionic split components of the wave which cause the periodic pattern. If, however, the thickness of layer be large, the frequency of the periodic pattern will be quicker and the intensity lowered. Based on the above considerations various types of frequency and amplitude variations in the periodic pattern of fading, observed during different hours of the day, could be explained. Incidentally it may be mentioned that the effect of magnetic field at the ionosphere on such fadings has also been discussed, and it has been shown that higher magnetic field will reduce the duration of the presence of upper extra-ordinary ray along with the Pedersen ray and hence the pattern is likely to be less complicated. This may explain the difference in fading patterns obtained at places situated at different latitudes.

9. Predicted and Observed Values of Electronic Densities in the Ionosphere.

S. S. Banerjee, R. N. Singh *and* R. R. Mehrotra, Banaras.

Graphs have been drawn to indicate the predicted and experimentally observed values of electronic densities and their variations in the F_2-region of the ionosphere. For calculation of the above, monthly noon maximum ionization has been considered, the values of which were obtained from ionospheric data recorded by the Research Department, All India Radio, Delhi, for more than two and half years, beginning from December 1945 to June 1948. In the above data, predictions of electronic densities were made for comparatively long range of three months. The periods of maximum deviation in the predicted values from the observed ones have been found to occur generally during the months of March to June in 1947 and 1948, when the error has been, some times as high as 80 percent. Analyses of the observations show that the discrepancy is more frequent and pronounced towards positive direction. The results obtained further indicate that short period prediction of electronic densities is more useful for practical radio communications and weekly observarions of the sunspot (calcium flocculi) numbers should be taken into account for such predictions of electronic densities. The importance of such analyses lie in day to day prediction of inospheric conditions which are of great value for maintaining continuous radio service between two distant stations.

10. Improvements in Building Construction and other Structures.

P. B. Ghosh, Sibpur.

The paper deals with improvements in Building Construction from the point of view of lightening the dead weight of the structure, economy of space, thermal insulation and acoustics, and reduction of cost of construction and the time needed for erection. It also relates to economy and facilities of construction of other structures such as boundary walls, retaining walls, cofferdams, steining of wells, and the like. The process is also an aid to prefabricated construction.

The method of construction is based on the invention of blocks for building purposes, or for construction of structures of masonry, or the like, which are solid blocks (without cavities or hollows passing therethrough) but are provided with projections or arms to assist in bonding and for the purpose of enabling the structures to be produced with hollows or cavities in them. The blocks can also be used for producing solid walls which will be stronger and more economical than those obtained by ordinary conventional parallel piped bricks. They can be moulded, dried and burnt like ordinary bricks, and require less amount of coal for burning them, and the time of moulding and burning the blocks is reduced.

11. Administration, a Science for Engineers.

J. N. Basu, Jadavpur.

During the last 70 years, along with the growth of industrial concerns, the principles of administration have been framed on established facts and a science is developed out of them; since science is nothing but accumulated or accepted knowledge which has been systematised and formulated with reference to discovery of general truths or operations of general laws. Knowledge of engineering & technology is a vital requirement in various phases and elements of administration; so engineers and men of technology are not only to play an important role in administration; but are to contribute greatly to the advancement of the science of management specially by way of research, design, patent, planning, economic production, industrial layout and the like. Along with the growth of science of management, it was found necessary to acquaint persons with the science who intend to work in industrial concerns. Engineers, technicians & technologists without the rudimentary knowledge of administration-science, were found extremely unsuitable to serve any industrial firm. Consequently the science of administration was included not only into the curriculum of commerce Colleges but also into the courses of studies of Colleges and Universities for Engineering & Technology, throughout the whole world.

A table has been prepared with reference to the studies of the subjects for students of Engineering & Technology in the nine colleges in U.S.A., in six colleges in U.K., in seven colleges in Germany, five colleges in India and one college in Switzerland and at the end one Technical School of Engineering in Germany. From this table it will be found that this subject is taught in the 3rd and 4th year classes of the Engineering Colleges. The different names by which this subject is called at different Universities are also mentioned. This subject is made compulsory for mechanical Engineering course almost in all colleges, throughout the world. U.S.A. being the pioneer to evolve this science, has gone further to introduce this science, in the form of a course entittled "Business and Engineering administration" in M.I.T. and " Industrial Engineering Administration" in Cornell University, and "business administration" in the Harvard University lasting four years leading to the degree of S.B. and with further study of the subject granting S.M. & PH.D., thereby the subject is brought up to the same standard as courses of Mechanical Engineering, Naval Engineering, Electrical Engineering, Chemical Engineering and the like. In Germany, Munich & Berlin T.H. introduce the course. "Business administration" and "Business & Industrial Science" respectively, leading to the degree after four years of study.

In a joint Informal Meeting of the Institution of Mechanical Engineers, London with the institution of Civil Engineers & the institution of Electrical Engineers, London, held on 24th March, 1939, the subject, "The Importance of Training in Management for Engineers " was discussed. It was pointed out that devastating results arose in undertakings, both large and small, due to lack of knowledge of the elementray principles of management. The subject was so wide and so full of matter for argument that the following two points were accepted without discussion.

(1) That the fundamental principles governing sound industrial management are now sufficiently clearly defined to be teachable.

(2) That a knowledge of those principles would be of advantage to an Engineer in the pursuit of his profession.

So it can be safely stated that importance of the study of the science of administration for Engineers, is well recognised throughout the whole world. It remains still to be observed how we in India should attach importance to this subject in the Universities and Colleges for Engineering & Technology in India. Uptil now the subject did not receive fairly satisfactory treatment in most colleges of Engineering and Technology in India. Let us hope that along with the advancement of the Engineering & Technological education in India, the science of administration will also receive more importance in the curriculum of studies for Engineering & Technological graduates.

12. Heat-Treatment of Steels without Decarburization.

R. A. P. Misra, Bombay.

The problem of decarburization in the commercial heat-treatment of steel is discussed with the undesirable effects of this phenomenon on the mechanical properties of various components. Essential requirements of a commercially successful atmosphere for heat-treatment furnaces are ennumerated. Details are given of a system of furnace atmosphere developed by the author in conjunction with Messrs. Wild-Barfield Electric Ltd., of Watford, England.

The results of experiments carried out on the heat-treatment of steel samples of various compositions are given using this system of atmosphere generation. The author relates an incident which initiated this line of development and points out the importance of following up small clues in the development of Scientific and Industrial research. The theory underlying this development is discussed briefly with special relation to the CO/CO_2 equilibrium diagram and the effect of the temperature of generation on the character of the furnace atmosphere. Though no fundamentally new discovery is claimed, it is considered that the practical development of this invention marks a distinct advance in the technology of the heat-treatment of steels. The theoretical explanation advanced for the success of this system should help to provide a clear

er understanding of the factors involved in the control of decarburization during heat-treatment, which are even now imperfectly understood by the majority of Metallurgists and Heat-Treatment Technicians in England and America.

Finally a plea is made for the encouragement of Industrial Research by the industrial units concerned as the author feels that only development along this line can help to improve the quality of Indian manufactured goods.

13. Wear in Producer-gas Converted Petrol Vehicle Engines.

L. C. Verman, Mohan Lal Khanna, S. K. Das Gupta *and* K. A. Nair, Delhi.

A new Lease-Lend 160" wheelbase 3-ton 1943 model Chevrolet truck fitted with a modified "Simpson" gas plant and used for the various departmental road trials had completed 9,000 miles of run mostly on producer-gas. Rectified spirit and a little petrol were also used as fuel. The crankcase oils, after every 2,000 miles of run, had been analysed. The data collected has been utilized to determine the wear caused in the petrol vehicle engine, when converted to operate on producer gas under Indian road conditions. The wear observed has been compared with that observed by Bowden and Kennedy working in Australia, using Chevrolet, Ford V8 and Bedford trucks and operating on producer gas using charcoal as fuel.

It has been shown that if the gas plant is maintained to satisfy the Indian specifications, there is no excessive wear on gas as compared to that on petrol. The pressence of large amounts of fine sand in the sludge shows that it will pay to give more attention to air cleaning to keep out atmospheric dust from the engine.

14

H. K. Mitra, Jamshedpur.

For the manufacture of firebrick, plastic fireclay is an essential requirement. If the Pyrometric Cone Equivalent (softening point) of the plastic clay is not high, the physical properties of the resultant firebrick are impaired. To obviate this difficulty, a technique has been developed for manufacturing firebrick entirely from non-plastic Fireclays. The brick thus made meet High Heat Du y Specification and it is not beyond the realm of possibility to make even Super Duty Firebricks by this process.

15. A Study of Coarse Filtering Media for Portable Producer-gas Plant Filters.

S. K. Das Gupta *and* Mohan Lal Khanna, Delhi.

The materials most frequently used as coarse filtering media in the first two stages of gas filtration of a portable producer gas plant in India are cotton waste, jute, sisal, coir and munj. The suitability of these materials in these filters has been investigated by studying the flow characteristics of air through these materials. Using a linear filter, a study of the pressure drop across the filter bed in relation to air velocity with different packing densities and packing depths was made. The pore size of charcoal dust particles passing through the filter bed at maximum packing density and different depths of packing in the five materials has been determined.

Using these materials in a radial filter, the pressure drop at various air velocities at maximum packing density has been determined.

The data collected so far helps one to choose the material most suitable for the first and second stages of gas filtration and in the efficient designing of the radial filters most commonly used in India with a tolerable pressure drop.

16. Scope of Dry Cyclones in Producer-gas Filtration.

S. K. Dasgupta *and* Mohan Lal Khanna, Delhi.

The possibility of the use of dry cyclones in portable producer-gas plant has been investigated. Two cyclone filters, one for high and the other for low rate of gas flow and to arrest dust particles of size 5 microns and over, were designed and constructed in these laboratories. The relationships between pressure drop and flow, between the mean diameter of particles and the percentage dust collected and between the percentage dust collecting efficiency and the flow in the case of both these filters have been studied. Bench tests with these two filters when replacing the initial filters of a mobile producer-gas plant were carried out. Though these cyclones filters could not replace all the three filters of a portable producer-gas plant, yet it was possible to replace some of the existing types of filters used in the initial stages of gas filtration.

17. Investigations on Colorimetric Methods of Metallurgical Analysis. Part VIII. Estimation of Silicon in Steel, employing the Duboseq type of Colorimeter.

G. V. L. N. Murty *and* N. C. Sen

A procedure has been described for the colorimetric estimation of silicon in steel by employing the Duboscq type of colorimeters. This is shown to be capable of yielding reprodicible results, comparable in regard to their accuracy, with those obtained by absorptiometric and gravimetric methods. It is clear from the data embodied in this paper that the visual procedure now suggested could be conveniently employed for the analysis of steels covering a wide range of variety, both in regard to the number and nature of the constituent elements present and their percentage concentration.

Pages 239 to 245 Printed by Kalipada Mukherjee at Eka Press, 210, Cornwallis
Street, Calcutta.

PROCEEDINGS
OF THE
THIRTY-SIXTH
INDIAN SCIENCE CONGRESS
ALLAHABAD, 1949

PART IV

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PROCEEDINGS

OF THE

THIRTY-SIXTH INDIAN SCIENCE CONGRESS

ALLAHABAD, 1949

PART IV

Section V: (Geology & Geography)

LATE ABSTRACTS

1. Regional Planning Units of Lower Godavari Area.

V. L. S. PRAKASA RAO, (Calcutta).

In this paper, the author discusses the need for a radical rearrangement of administrative boundaries in the Lower Godavari Area for the purposes of regional and local planning, and pleads for regional planning units. The defects of the present economic development policy are pointed out and the lines of future policy indicated in the shape of representative suggestions. Six major regional planning units are suggested instead of the present 9 taluks.

A regional planning unit is a geo-economic unit with a homogeneous landscape expression of life. Such a unit is characterised by uniformity of resource-use and economic problems. The following six major regional planning units are being suggested by the author for the Lower Godavari Area. (The three fold division of the East Godavari district into agency, uplands and delta indicates the hazy concept about geographical facts and the haphazard translation of geographical theories into action, hence not acceptable by the regional planner.)

Regional Planning Units: (1) The dissected gneissic zone (part of the Eastern Ghat zone), (2) the coastal and rivering plains, (3) the sandstone zone, (4) the agricultural regions like the paddy zone, the paddy-sugarcane zone, the coconut zone etc. (5) the mangrove zone and (6) the urban-industrial and 'urban' zone.

The above 6 units are criss-crossed by 9 taluks and 36 firka boundaries resulting in (1) defective regional development policy, (2) lop sided economic development and (3) interunit socio-economic disbalance.

2. Graphite deposits of Commercial value found in the neighbourhood of Anara, near Purulia, Manbhum Dist., Behar.

S. Deb (Calcutta).

Graphite deposits of economic importance found scattered in the neighbourhood of Kalajori, Bongora and Jihurbona, situated at a distance of about 3½ to 4 miles S.S.E. of Anara Railway Station on the Adra-purulia line, B.N.R.

Graphite is found associated with the pegmatite veins, cutting the country rock which is nothing but mica-schists and quartzites. Pegmatites cutting the mica-schists are rich in graphite concentration. Usually the graphite veins are found to occur in the semi-decomposed schist-rock and several thick veins of graphite are being prospected in this area. The thickness of the veins varies from 1|2 inch to 4½ feet, and they indicate a definite improvement in quality after a certain depth. It appears that the graphitisation is a post-Pegmatic phase, probably brought about by carbonaceus gases, after the pegmatitic instrusions.

The graphite is of flaxy variety and contains about 60 to 65% of graphitic carbon.

3. The possibilities of recovery of sulphur in the manufacture of synthesis gas from coals of Hazaribagh and Ranchi Districts.

R. Ghosh and R. K. Dutta Roy, (Geological Survey of India).

Synthesis gas is a mixture of hydrogen and carbon monoxide and serves as a raw material in the manufacture of synthetic liquid fuel by Fischer-Tropsch process. This may also serve as a source of hydrogen for the hydrogenation of coal to liquid fuel by Bergius process.

It is produced by the gassification of coal with oxygen and steam.

During the process of gassification, a major portion of the sulphur compounds breaks up and is liberated in gaseous form. The gases to be used in the manufacture of synthetic oil should be free from sulphur and sulphur compounds as they poison the catalyst.

On passing the synthesis gas over the catalyst, lower hydro-carbons are first formed which subsequently polymerise to higher hydrocarbons to yield liquid oil.

Coal occurs in open-seams in Ranchi and Hazaribagh districts and as such are suitable for hugh raising required for the manufacture of synthetic oil. These coals contain on the average 0.5 per cent of recoverable sulphur. Sulphur recovered during the process of cleaning or purification of the gases may meet the sulphur shortage of India to a considerable extent.

Section VI: Botany.

A little-known multipurposes double-stain.

N. K. Tiwari, Banares.

Double staining is a routine method for securing differential contrast of the cell and tissue components and is regularly employed for microscopic work. The customary routines, however, are long and tedious, and, moreover require practice and critical judgement. A method that is simple, rapid, at the same time effective, was described by C. J. A. Berkely (Ann. Bot. 48,1934, p. 31011) and has been tried by the writer. It is easy, automatic and gives rapid and dependable results. It can be employed both for temporary as well as permanent mounts. Only *one* manipulation is necessary.

Moreover the present writer has found it useful beyond its original scope. For instance, he has obtained differential staining of the exine and intine of the mature and germinating pollen ghains and differential staining of the pollen tubes in stigmatic and stylar tissue. Presumably it will be found serviceable for other purposes as well. To make the technique widely known it is being given in some detail.

The stain is a solution of 1% cotton blue and 1% Basic fuchsin in Lactophenol. The standard concentration recommended is as follows:—

1% cotton blue in lactophenol		4 c.c.
1% fuchsin	do	2 c.c.
Lactophenol (made up as follows		50 c.c.
Carbolic acid crystals (C.P.)		20 gm.
Lactic Acid	(sp. gr. 1.21)	20 c.c.
Glycerine	(sp. gr. 1.25)	40 c.c.
Dist. Water		20 c.c.

Sections, pollen grains and styles (preferably split longitudeinally and spread out) fresh or preserved, are mounted direct in the solution. In most cases, almost immediately, the differential staining is secured but the *full* colour and *complete* differentiation take some time.

As lactophenol does not evaporate, preparations made for immediate examination keep well and in keeping the preparations become more and more effectively stained. Differentiation is automatic and overstaining practically nil. Lactophenol, moreover has a clearing effect and improves the refractive index. If required the preparations can be made permanent with little extra labour.

In actual practice the strength of the solution and the relative proportion of the two stains may have to be varied to suit different materials. In general for thicker sections and material a lower concentration of the dyes will be found more successful. The following colour effects are produced. Protoplasm, Protein, mucilage, etc. Blue; lignified walls and cuticle Red. Moreover, the lignified walls pass through different shades of red, during the process, according to age and maturity, and as a rule, the older the lignification, the more slowly it stains *e.g.*, secondary Xylem, red; meta Xylem, pink; proto Xylem, Pale pink.

2. Observations on the generative nuclei of certain solanaceae.

N. K. TIWARI and SHANKERJI SHRIVASTAVA, Banares.

Pollen grain characters, the number of nuclei in the mature grains and the morphological characters of the generative nuclei are credited by some authors with systematic significance. The under-mentioned species were investigated by the customary and modified (vide Science and Culture, 13,1948, p. 390) aceto carmine new Chromo-acetic (Proc. Ind. Sc. Cong. III 1947 p. 170) and *new* aceto-haematoxylin (supra) techniques, to test the validity or otherwise, of the view: *Capsicum annuum, Solanum melongena S. nigrum, S. tuberosum, S. Xanthocarpum, S. lycopersicum, Nicotiana plumbaginifolia* and *Datura alba*. The mature pollen grains are 2 nucleate. The characters of the generative nuclei, of the species in question, are described. These vary from species to species, being crescentic, plano-convex, double convex, reniform, elliptical etc. In length they extend from one fourth to three fourths, or more, of the grain diameter. In *Capsicum* and *S. nigrum* the nuclei are somewhat undulate. The variations cannot at present be consistently interpreted. The present data do not permit corroboration or denial of the view. The morphology of the grains has been mentioned in passing. The investigation has been carried out with the aid of the U. P. Government Research Grant.

3. Remarks on the germination of Psidium guava seeds.

N. K. Tiwari, Banares.

Fruits and seeds with stony endocarps and testas show interesting features in germination. In the present paper a brief account of the stony seed is given. The seeds maturing in winter were found to be germinable only in the following rainy season. At the micropyle a disc shaped plug which is hard to detect in the seed, is present. During germination, the radicle emerges by lifting up this plug. It is *stumpy* with a disc shaped truncated end, at first. From the centre of this later a normal root arises. The germination is epigeal. The seeds were sown on moist blotting paper in covered petri dish. The first seed germinated a fortnight after sowing, and thereafter, other seeds kept germinating, singly or in lots for about two months.

4. Aceto-Hæmatoxylin, a new nuclear stain.

N. K. Tiwari, Benares.

Aceto-carmine is being extensively employed for quick differential staining of nuclei. Its red colour, however, is a disadvantage for critical high power observations. This is remedied by the incorporation of a trace of iron. But the iron requirements of different meterials, to produce the maximum desirable results, vary and a number of trials are necessary to determine this. In this respect Aceto-Orcein scores an advantage. Recently, however, I have tried Haematoxylin dissolved in Acetic acid. But in place of the customary *aqueous* 45% strength of the acid I have used 45% acetic acid in 50% or 25% glycerine (vide Proc. Ind. Sc. Cong. III 1945, page 81). This medium has a higher refractive index than water and therefore yields better results. 1 gram of dye per 100 c.c. of the solution is used. Incorporation of glycerine also avoids the necessity of ringing the cover glass to prevent evaporation. The results so far obtained on pollen grains are satisfactory and encouraging. The nuclei have been found to become differentially stained. The differentiation is better *after* pretreatment with NaOH (vide Science and Culture, 13,1948, p. 390) Freshly prepared stain can be used and gives fair results. But staining improves with age. The trial sample of the stain was made in November 1948. Future will show how long the stain will remain serviceable and improvement maintained. Trials are in progress to introduce a cytoplasmic stain to produce contrast effect. I am thankful to Shri Skankerji Shrivastava, M.Sc., my Research Assistant for the various trials on which the present results are based.

5. Embryogeny of Notothylas Chaudhurii and its Theoretical Significance.

R. L. Nirula, Nagpur.

Some time back, the author had described a new species of Notothylas from Nagpur which was named N. Chaudhurii after the late Professor H. Chaudhuri of the Punjab University. Its external morphology and internal structure were studied in a general way and it was established beyond any doubt that it is a new species. It possesses a row of specialised cells along the margin of each valve as in *N. indica,* has no columella as in *N. levieri* and *N. verdoorni* and possesses dorsal sporogonia as in *N. verdoorni.* In other characters, such as the entire absence of marginal sporogonia, greater thickness in the middle of the thallus and comparatively greater meristematic growth in the seta, it may be calleh somewhat peculiar to itself. In fact, it can be rightly recognised as a synthetic species. The plants are monoecious and protandrous. The antheridia originate endogenously and are in groups of two or three inside each artheridial cavity. The development of the reproductive organs and the embryogeny of the sporophyte were not studied previously. This work has been in progress for some time and certain observations in the embryogeny of the plant are worth while reporting at this stage. The earliest stages in the embryogeny of the species conform to the usual anthocerotacean type, these being the oospore dividing by transverse and longitudinal walls to form three tiers of four cells each, the periclinal walls in the uppermost tier separating the central tissue (endothecium) from the peripheral tissue (amphithecium). The origin of the archesporium is, however, fundamentally different in this species from the other Anthocerotales in that it developes from the entire endothecium while the amphithecium forms the wall only. Later the archesporium shows a regular alternation of fertile and sterile cells which extend completely across the capsule except for the outer amphithecial tissue which is much less developed. Chloroplasts are present in the wall but the stomata are wanting. The sterile cells or the pseudoelaters are short and have a few spiral thickened bands a condition intermediate between the definite spiral bands in Megaceros and Dendroceros and the smooth walls in Anthoceros.

The origin of the archesporium from endothecium alone is a point of far reaching significance and confirms the observations of Dr. S. K. Pande in *N. levieri*. In Anthocerotales in general, the origin of the archesporium is from the inner layer of the amphithecium while the endothecium forms the columella. The species while resembling the Anthocerotales in the majority of its characters, differs from the order in the embryogeny and resembles the rest of the Hepatics in that the endothecium forms the archesporium. It therefore serves as a connecting intermediate type between the Anthocerotales and the other Hepaticae and supports the view that Anthocerotales should be retained within the Hepaticae.

While in almost all sporogonia, no columella was seen, in one solitary case, a columella-like structure was noticed in the middle. No importance might have been attached to this feature if it occurred in a separate plant for the latter might then have been taken as belonging to a different species but the sporogonium in question was seen side by side with another one without any columella on the same plant. This an observation of the most astounding interest, though observed in a single case so far. It demonstrates that the columelloid and the non-columelloid species of Notothylas are distinctly related. Since the other characters of *N. Chaudhurii*, as discussed in a previous communication on the species, suggest that Notothylas is a reduced genus, this occurrence of a columelloid structure can be interpreted as a reversion to the ancestral condition.

6. Microsporogenesis, Development of Pollinium and Male Gametophyte in *Daemia extensa*. Br.

R. L. NIRULA and P. D. GADKARI, Nagpur.

At a very early stage, there appear in each stamen two plates of archesporial cells developing eventually into two microsporangia. Each plate, as usual, gives rise by periclinal divisions to an inner primary sporogenous and an outer primary parietal layer. The sporogenous cells are arranged in their characteristic orientation in 3-6 radial rows, each row consisting of 9 or 10 cells. The microspore mother-cells undergo the two usual meiotic divisions. After the first division, a cell wall separates the daughter nuclei. Similarly, after the second division, walls parallel to the one already formed are laid down. Each microspore mother-cell thus gives rise to a linear tetrad. It is evident that the method of microspore formation is successive.

The microspores do not get rounded, nor do they become free from each other But they give rise to a pollinium. During its organisation, several changes such as increase in the size ofthe nuclei, receding of the microspore protoplasts from the walls and development of the pollinium wall take place more or less simultaneously. The pollinium wall is formed by the outer walls of the peripheral microspores and is probably laid down by what is known as apposition. Eventually, the microspores, now better called as the pollinium cells, become closely compacted, their linear arrangement becomes disturbed, the pollinium wall becomes very thick and the ripe pollinium lies freely in the cavity of the microsporangium.

The tapetum is of the secretory type. It is several layered to begin with, becomes reduced to a two layered jacket during the course of the first division and when the meiosis is complete, it becomes one layered. Throughout, the tapetal cells remain uninucleate, a few cases with binucleate condition being seen only after the completion of the meiosis that is during the pollinium development.

The male gametaphyte begins its development in the unremoved pollinia. Rudimentary pollon tubes are seen developing from some of the pollinium cells (microspores) each of which later shows the generative nucleus and the fragmented tube nuclei.

7. The Algae of Cultivated Soils with similar physical texture.

Ella A. Gonzalves and Kusum S. Gangla, Dharwar.

This investigation was undertaken to ascertain whether the nature of the crop affected the soil algal flora, when other conditions such as soil texture, climate etc. were identical. Samples of soils of similar physical texture from four fields of Bajri, Gram, Dry wheat and Irrigated wheat were collected from Niphad. The soils were alkaline, rich in lime and fairly retentive of moisture. A record of the sequence of appearance of the various species in liquid and moist cultures of the air-dried soils was maintained for two years.

Most of the forms belonged to the Cyanophyceae, the Chlorophyceae being only recorded from the irrigated wheat soil. Diatoms were rare. The absence of greens was attributed to the alkaline and cultivated nature of the soils and also, to a certain extent, to the nature of the culture solution used. Almost equal numbers of algae were recorded from the Bajri and Gram field soils, a fact which seemed to be correlated to the pH and lime content, which were almost identical in these soils. Similar observations were made with regard to Dry and Irrigated wheat soils.

As only slight variations were observed in the algal floras, it is evident that the nature of the crop does not affect the soil algas.

8. The Algae of Soils Differing in Physical Texture.

Ella A. Gonzalves and Kusum S. Gangla, Dharwar.

This investigation was an attempt to determine the relationship which exists between the algal flora and the physical texture of the soil.

Five types of soils were selected for study viz. 1) Black (2) Murumad (3) Sandy (4) Goradu and (5) Limy.

Liquid and moist cultures were maintained for a year. The black soil yielded thirteen, Murumad eleven, Goradu ten, Sandy thirteen and Limy four species. The number of species in the Murumad and Goradu soils was almost equal and was attributed to almost identical physical textures, lime content and pH of the soils. Though the number of forms observed in the black and sandy soils was not very much more than in the former two soils, the degree of growth was very lururiant. A combination of three factors viz. moisture-retaining capacity, certain favourable amounts of lime and of organic matter seemed to be responsible for good algal growth here. In the limy soil, the lime content seemed to be the limiting factor. The soil algal flora hence is the result of a combination of factors and one factor alone, such as physical texture, cannot influence it.

9. "A New Periodic Phenomenon in the Cultivation of Sorghum Vulgare Pers., (Jowar)."

In a series of experiments conducted over a period of three years at Patna, it was found that Jowar, when sown early in April as the fields are empty then, shows greater luxuriance of vegetative and reproductive growth, than the crop sown at the normal time, i.e., the end of June or early in July.

The increase in the yield of grains is very significant. Every seed produces several shoots, each bearing several panicles, which are further supplemented by a process of profuse tillering and ratoon crop. Thus the total yield is several-fold than the ordinary crops.

High temperatures in summer months with longer photoperiodic ranges may have something to do with this phenomenon in Jowar ; and possibly in other crops too, opening up a new field in 'Grow more food campaigns' and in agriculture.

10. A New Method of Sexual Reproduction in some Soil Chlamydomonadaceae.

A. K. Mitra, (Allahabad).

During a study of Indian Soil Algae two new species of *Chlamydomonas* and a new species of *Carteria* (viz. *Chlamydomonas Iyengari, C. indica* and *Carteria eugametos*) were observed to produce gametes which fuse by their posterior ends. In such cases one of the gametes acts as the recipient one, while the wall of the active gamete, after its contents have passed into that of the former, fuses with the wall of the recipient gamete and forms a loose covering around the zygote. The zygote has the same number of flagella as the gametes but is larger than the vegetative cells, remains motile for a long time and frequently divides without rest, although resting stages are later formed.

11. A Bacterial Disease of Coconut Fruits.

S. N. Tamhane, Nagpur.

A new disease of the coconut fruits has been reported in this paper. The disease probably commences after some accidental injury to any one of the three depressions on the fruit. It effects a rot of the endosperm or copra within, and is detected with difficulty since the outer shell remains intact. With the progress of the disease, the rotting endosperm gets separated from the test which itself remains adherent to the shell. Eventually the endosperm becomes a slimy mass and begins to emit an unpleasant odour. Moist conditions favour the progress of the disease. In the dry fruits, the disease, when present, is seen in an arrested condition.

Cells of the endosperm are generally occluded with bacteria. The latter show active motility, even though crowded. The disease could be transferred to wet healthy coconuts as well as pieces of copra by direct infection experiments. From the harder portions of the infected pieces, a bacterium was isolated in almost pure cultures and its pathogenecity established by artificial inoculations.

The organism is a slow growing one, the surface colonies appearing in 36.48 hours on Bouillon-agar plates. In the beginning, they are tiny, .5-1 mm. in diameter, raised and round and appear as translucent dots. After 4-5 days, they increase in diameter and begin to show fine radiating lines starting from the centre of a colony and ending with its circumference. In each colony, a central area then makes its appearance and develops into a papillum. At the end of about two weeks, the papillum broadens at the base, where a whitish circle makes its appearance. The umbonate colony now becomes grumose developing chalky-white circles with clear spaces between them and also for short distances along some radii. The depth colonies are also umbonate. The individuals are small coccus like rods occuring singly, in groups of two or three and sometimes in chains. They show motility of the swimming type with frequent spells of tumbling. Polar flagella have been demonstrated in some preparations.

12. Life History of Leucaena Glauca Benth.

V. R. DNYANSAGAR, Nagpur.

The paper deals with the normal life history as also certain degenerations in the anthers and ovules.

1. The differentiation of the archesporial cells in the microsporangium is rather late. The parietal tissue is composed of endothecium, one or two middle layers and a tapetum. The tapetum is of the secretory type and its cells remain uninucleate. The micropore mother-cell gives rise to tetrahedral as well as isobilateral tetrads of microspores. Cytokinesis takes place by furrowing.
2. The ovules have two integuments of which the outer forms the micropyle. The archesporium in the ovule is sub-hypodermal and consists of a single cell which functions directly as the megaspore mother-cell. In addition to the normal linear tetrads of megaspores, a some what shaped tetrad was observed and in one case, a linear row of only three megaspores was seen.
3. The chalazal megaspore develops into an embryo-sac which is of the normal 8-nucleate type. The antipodals form definite cells.
4. The primary endosperm nucleus divides by free nuclear division long before the segmentation of the oospore.
5. Degenerations are met with in the microsporangia as well as embryo-sacs. In the microsporangia, these occur at the microspore mother-cell stage. The non-functioning microspore mother-cells are of two types, polygonal and rounded; in the ovules the degenerations occur after the organisation of the embryo-sac.

13. Studies in Indian Anthocerotales.

II. On the Morphology of *Anthoceros Jackii St.*

S. K. PANDE & D. C. BHARDWAJ, (Lucknow).

This note describes the life history of *A. Jackii,* a yellow spored species, found growing on boulders near running stream, near Dhobighat, Ranikhet.

The species is monoecious and protandrous. The antheridal chambers are small and lie round the sporogonia. The chambers are mostly diandrous and the antheridium is spherical and short stalked. The sequence of development of the antheridium is the same as described in other species of Anthoceros. The archegonia, which develop shortly after the antheridia, are of the normal type found in the genus. The mature archegonium, usually has 5 neck canal cells. The delimitation of the endothecium and amphithecium is of the normal type. The archesporium, which arises from the inner amphithecium, is one cell thick. The foot is large and deeply embedded in the thallus and shows haustorial processes. The columella is always 16 celled as seen in a cross section.

14. South Indian Hepatics I.

S. K. Pande, D. C. Bhardwaj and Ram Udar, (Lucknow).

The present note includes a taxonomic account of 10 species of South Indian Liverworts collected by Rev. I. Pfleiderer, chiefly from Kudure Mukh (6000 ft.) during the years 1911 and 1913. Pfleiderer lists 123 species from Malabar, including South Kanara and the Nilgiris, belonging to 44 genera. The speciments described here are:—

LEPIDOZIACEAE

1. *Bazzania nudistipulum* St.	Kudure Mukh.

HARPANTHACEAE

2. *Saccogyna alternifolia* St.	Kudure Mukh.

PLAGIOCHILACEAE

3. *Plagiochila Richteri* St.	Kudure Mukh.
4. *Plagiochila Wornoffii* St.	Kudure Mukh.

FRULLANIACEAE

5. *Frullania moniliata* Nees.	Kudure Mukh.

LEJEUNEACEAE

6. *Archilejeunea apiculifolia* St.	Kudure Mukh.
7. *Cheilolejeunea indica* St.	Kudure Mukh.
8. *Harpalejeunea indica* St.	Kudure Mukh.
9. *Ptychocoleus fertilis* (Nees) St.	Mangalore.
10. *Eulejeunea Lindbergii* St.	Kudure Mukh.

15. Studies in Indian Anthocerotales.

I. On the Morphology of *Anthoceros Crispulus* (Mont) Douin.

D. C. Bhardwaj, (Lucknow).

This note includes an account of the Life history of *A. crispulus,* a dark spored species, from the neighbourhood of Lucknow.

The species is monecious and protandrous. Antheridia appear early in winter, about the month of December. The sequence of development is the same as described for *A. levis* Linn., and other species of Anthoceros. The archegonia begin to develop a little later than the antheridia. Details of development are of the usual type found in the genus. The mature archegonium usually has 4 neck canal cells; occassionally, as many as 6 neck canal cells have been found. The first division in the fertilised egg, unlike other species of the genus, is transverse. In this respect *A. crispulus* resembles *N. indica* Kash. The later course of development of the sporophyte is the same as in other species of the genus. The archesporium, which arises from the inner amphithecium, is one cell thick. The foot lies embedded deep into the thallus and shows no haustorial processes.

16. On the Occurrence of *Pityosporites* Seward in a Lower Gondwana Tillite from Australia and its possible Relationships with *Glossopteris.*

DIVYA DARSHAN PANT, Allahabad.

By macerating a piece of Lower Gondwana Tillite from Bacchus Marsh, Victoria (the material, which is a fragment of B.M. specimen No. 1925, 965, locality Coimadai Creek, Bacchus Marsh, was kindly given to me by Professor Sahni who obtained it through the courtesy of Mr. W. N. Edwards of the British Museum), the author has obtained besides a large number of other spore types, forms with two bladdery wings, *Pityosporites* Seward some of which have a transversely striped body. While this occurrence of many spore types in the tillite which are essentially similar to those in the Lower Gondwana rocks and of well marked impressions of *Gangamopteris* and other typical Glossopterids (reported earlier by Sussmilch, Du Toit and Leslie from glacial and interglacial beds in Australia and South Africa) indicates the existence of at least some of the members of this flora during the ice age, it is suggested here that the occurrence of the two winged spores (*Pityosporites*) may possibly indicate the the existence of *Glossopteris* itself during the glaciation.

Similar spores, some of them even identical in size and shape, have been found to be of widespread occurrence in the Lower Gondwana times where they are always closely associated with *Glossopteris.* Virkki (Mrs Jacob) has reported *Pityosporites Sewardi* and *Pityosporites* spp. (*Proc. Ind. Acad. Sc.* 1937 and *Proc. Nat. Acad. Sc. Ind.* 1946) in shales from Central India and from horizons only 1½' and 25 feet above the Talchir Boulder Bed in the Salt Range where *Glossopteris* is a common fossil. Seward (*Brit. Antarctic Expedition 1910 Nat. Hist. Rept.* 1914, p. 23) had earlier reported the occurrence of *Pityosporites antarcticus* in the siliceous matrix of a partially decayed stem of *Rhexoxylon Priestleyi* in *Glossopteris* bearing rocks in Antarctica and he was inclined to believe (*New* Phyt. 1933 p. 313) that this might possibly be the spore of *Glossopteris.* Thomas (*Ann. Bot.* 1931 p. 667) records the occurrence of two winged spores similar to Seward's *Pityosporites* "in a shale of Lower Beaufort plant bed at Lidgetton, Natal which contained only the remains of *Glossopteris* leaves and *Phyllotheca* leaves and stems." (Prof. Seward, *loc. cit.* also mentions that Dr. Thomas is engaged in a study of the spores of *Glossopteris* but a detailed description of these spores could not be available to the author for comparison with the Indian and Australian specimens).

Even more interesting than these are Virkki's finds of *Pityosporites* with striped body, sticking to pieces of *Glossopteris* cuticle. In a piece of shale from the Permo-Carboniferous of New Castle, New South Wales which was "so rich in the fronds of *Glossopteris, Browniana* Brong. that rately a bare face of rock was exposed", she (*loc. cit.* 1937) obtained "hundreds" of these spores (*P. Sewardi*) and these alone from the surface of the cuticle of *G. Browniana* Brong., a number of them actually sticking to pieces of the upper cuticle. She has also found a large number of similar spores sticking to a piece of the lower cuticle of *Glossopteris communis* Feist from the Lower Gondwana (Lower Barakar) Daltonganj coalfield in Behar. In a similar case where Harris (Ann. Bot. 1941 pp. 47 and 48) has found *Caytonanthus* pollengrains from widely distant parts "in large numbers sticking to the upper cuticles of *Sagenopteris* leaves where they far outnumber other kinds of spores" he concludes that "such grains must have fallen on the leaf in life and prove that this *Caytonia* flowered at a season when the leaves were out." Could not the close association of *Pityosporites* (especially the species with a striped body wall) and *Glossopteris* leaves and the occurrence of these spores exclusively sticking in such large numbers to the cuticles of *Glossopteris,* in so distant parts of the Gondwanaland, suggest a similar conclusion? In any case it presents strong grounds for assuming that *Pityosporites* was the spore of *Glossopteris,* and if it is so then we might go further and say that *Glossopteris* had already come into existence during the ice age.

The two winged nature of the pollen and their similar mode of shedding in *Glossopteris* brings further support to the theory that the genus might be related to the Caytoniales (Sahni, *Bresid. Addr. Ind. Sci. Cong. Bot. Sec.* 1938, p. 19-23) an idea which had been pointed out by Thomas (*Phil. Trans* 1925) on the basis of the similarity in the shape, venation and cuticular structure of the leaves of *Glossopteris* and *Sagenopteris* and is also suported by the gymnospermous nature of the wood of *Vertebraria* (Walton & Wilson, *Proc. Roy. Soc. Edinb.* 1932).

17. On a Cluster of Male Cones from the Jurassic of the Rajmahal Hills in Bihar.

Divya Darshan Pant, Allahabad.

A collection of plant fossils was made by the author in January 1948 from Village Onthea in the Rajmahal Hills, Bihar. Among these a piece of rock studded with leaves of *Taeniopteris* showed impressions of a cluster of cones apparently attached to an axis of which little beyond the point of attachement is preserved. Five of these cones can be made out in the rock all diverging from the same point and situated in different planes. The strobili are oval with a slightly swollen distal end, size 5-7 mm. x 20-22 mm. A line demarcating perhaps the crushed sporophyll tissue is seen clearly round one of the strobili but it is absent in others. Each strobilus shows rhomboidal scars of the sporophylls which were perhaps spirally arranged round the slender cone axis. The cone axis is continued downwards as a thin stalk of the strobilus. A whitish encrustation is present in some of the sporophyll scars and is sometimes seen sticking as a horisontal ridge in the scar. On mounting this encrustation turned out to be the horizontally flattened male sporophyll having a narrow base, an expanded upcurved apex and elongated, oval microsporangia with proximally tapering ends on the lower side (the number of sporangia in each sporophyll could not be ascertained). The structure of the sporophyll is not unlike that of some of the modern conifers *e.g. Pinus*, but the spores obtained from these are of an elongated hexagonal shape, often occurring in clusters.

Comparison—The strobilus with a distinct border agrees in its general appearance and size with the description of the female cone of *Strobilites Pascoei* (Sahni, *Palaeont. Indica* 1928) a specimen which had been orginally described by Feistmantel (*Ibid.* 1877) as an inflorescence or fructification of Cycadeous plant". Other strobili in the same cluster resemble rather closely *Strobilites ontheaensis* (Ganju, *J. I. B. B. Iyeng. Comm. Vol.* 1946) which has been distinguished from *S. Pascoel* by the absence of a border forming an outline and by the presence of a transverse ridge in the scars. Srivastava (*Proc. Ind. Sc. Congr. Abs.* 1937) has suggested that *S. Pascoei* appeared to be the impression of *Carnoconites laxum* (this cone is perhaps 3 cm X 5 mm. and not 3 cm. X 5 cm. as is repeatedly mentioned in Srivastava, *Proc. Nat. Acad. Sc. Ind.* 1945 pp. 189 and 207; cf. fig. 75 nat. size). The similarity of all these cones, both male and female and their occurrence almost exclusively associated with impressions and petrifactions of *Taeniopteris* leaves is interesting. The spores are of the type found in a strobilus (also from Onthea) doubtfully assigned by Professor Sahni (*loc. cit.*) to *Elatocladus conferta*.

A detailed paper is in preparation.

Sec. X: AGRICULTURAL SCIENCE

1. The Ultraviolet Absorption Spectra of Mosaic Viruses of Sannhemp and Cowpea.

S. P. Raychaudhuri and B. Rama Moorthy, (New Delhi).

The light absorption curve of 0.11% solution of Sann-hemp purified by the method suggested by Markham and Smith (1946) in a centimeter layer of the solution on a

Nilgers Spekker Spectrophotometer E2, showed two maxima at 2770 A and 2632 A and a third one at 2958 A with an inflection point at about 2146 A. The absorption curve of a suitably diluted preparation of Cowpea mosaic virus obtained by the same method was quite similar to the curve for Sannhemp mosaic virus excepting for the fact that the maxima are generally displaced to a very small extent towards longer wave lengths viz. 2778 A, 2649 A, 2958 A and 2174 A with only week absorption in the region due to the nucleic acid component viz. 2630 A-2650 A. This difference between the two viruses in the extent of absorption in the region was not found to be significant because different samples of the Sannhemp virus itself showed similar variation in the region indicating thereby that like the ringspot virus of tobaco studied by Stanley, this virus also contains unstable nucleo-proteins which lose different amounts of nucleic acid due to hydrolysis in the preparation of different samples of the same virus.

From the degree of variation in the ratio of light absorption for wave lengths 2770 A and 2958 A for different samples samples of Sannhemp mosaic virus and the Cowpea mosaic virus, it appears that these two viruses have distinct differences in this region attributed in literature to the tyrosine—tryptophane components of the virus protein. According to Stanley and Knight (1941) these are the features to be expected in different and distinct strains and would thus explain the inability of the sannhemp mosaic virus collected at Delhi to be transmitted to Cowpea and vice-versa.

Section XI: Physiology

1. Some Local uses of Concentrated Vitamin A & D Oily Preparations.

S. N. Mathur.

Concentrated preparations of vitamin A & D such as Halbut Liver Oil of reputed firms, and "Adexolin" were used locally in conditions of various eye troubles and in dry eczematous skin conditions.

1. *Phlyctenular conjunctivitis*:—The local application of these preparations two or three time a day relieved the symptoms within twenty four hours and cured it in four days, *i.e.*, all the congestion totally disappeared.

2. *Granular Conjunctivitis*:—Local applications two or three times a day relieved the symptoms in two to three days and completely cured it in two to three weeks.

3. *Dry Eczematous Skin Conditions with or without itching*:—Innunetion two or three times a day cured them in three days.

2. Anti-Grey Factor in Yeast.

S. N. Mathur.

Presence of anti-grey factor in yeast for rats is well known. Its effects were tried in human cases mainly amongst student community *i.e.*, in young persons. Regular use of yeast or its preparations such as marmite for some weeks causes the complete disappearance of grey hair. It was observed that although the upper parts of the hair were still white the growing parts became black. In this communication it is not intended to name any particular separate B complex vitamin, for which fresh work is required to be done. Still the important point is that it does contain a factor, which may or not be identical with the rat factor, that prevents greying of hair in human beings also. Further it is to be pointed out that in old people it by itself did not prevent greying, in whom some essential gland factor is probably missing.

3. Spring and Fall of Hair.

S. N. MATHUR.

Some years ago I communicated results regarding the spring of haemoglobin. It then occured to me to carry on observations on myself regarding the same phenomenon about hair. During the course of these years I have observed that there is a regular fall season for the hair which almost synchronises, though somewhat later, with the fall of haemoglobin in the months of Autumn *i.e.* October and November. If the hair should fall at the rate of they fall during these months they should certainly result in baldness. Their fall is made up by the new growths in the months of spring which also synchronises with the spring of haemoglobin, *i.e.*, about the months of April and May, although a little later than the spring of haemoglobin. The interesting point noted about this spring and fall of hair is that with the advancing years the fall is increasing and spring decreasing resulting in progressive baldness year after year. A still more interesting feature about it has been that it can be prevented to a large extent by comparatively big doses of vitamin C and concentrated vitamin A & D preparations. Another point noted along with it has been that while in younger years vitamin C may be enough to prevent excessive fall, in older years it must be supplemented with concentrated A & D preparations. Probably in these concentrated A & D preparations it is the vitamin A which, as is alredy known, is specially required to keep the epithelial cells healthy. It is further suggested by these results that the requirements of vitamin A instead of decreasing with years, as is generally believed, actually increase.

4. Action of Ions on the Central Nervous System.

Part I. Action of Potassium and Calcium Ions.

B. V. PATEL, (Bombay)

A technique for the application of drugs to the ventricular system of the brain has been described. A study was made by the application of KCl and $CaCl_2$ to the brain centres utilising this technique and it was found that K salts stimulated the sympathetic centres, while Ca salts had the opposite effect. The effects of these salts on the central nervous system were studied by observing their effects on cardiovascular, respiratory, intestinal and skeletal muscular systems.

1. A critical survey of the actions of the autonomic drugs.

(M. L. CHAKRABARTY, Medical College, Calcutta.)

With the advance in knowledge in histophysiology the terms "Direct" and "Indirect" do no longer appear to be very appropriate in expressing the modes of action of the autonomic drugs especially in view of the methods employed for their studies. The principle of such methods is to render either the nerve or the effector tissue, the muscle or the gland functionless so that the effect produced by a particular drug may be attributed to its action on the unaffected tissue which still retains its function. In fact, this is an assumption by different workers depending, of course, on their respective experimental evidences. Unfortunately however, there is hardly any agreement amongst them in this matter. The same treatment according to one group of workers is reported to affect first the nerve tissue while according to the other it does not affect the same. The method of using drugs like nicotine producing a block, physiological denervation, is equally not above criticism.

The author therefore likes to examine critically the various evidences upon which the theories have since been built in light of the results of experiments obtained by workers in the line from time to time so that the actions of the autonomic drugs can be described with greater precision and better terminology may be coined to express their 'modus operandi'.

GENERAL SYMPOSIUM ON APPLICATION OF SCIENCE IN INDIA FOR SOCIAL WELFARE.

Held at the Vizianagram Hall, Allahabad University, on the 5th January 1949, under the presidency of

Sir K. S. Krishnan, F.R.S., F.N.I.

General President of the Indian Science Congress.

I

THE NATURAL RESOURCES OF INDIA IN RELATION TO SOCIAL WELFARE

Dr. D. N. Wadia, New Delhi.

The "proverbial poverty" of India can no longer be held as an excuse for inaction in the new free India when India's economy is viewed in the context of the many natural resources with which she is endowed. The natural resources of the country—agricultural, forest, water, besides mineral resources, when properly administered and developed can pay for all desirable, transformations in its social, economic and cultural life. They would also eventually help to evolve a politically homogeneous structure. The World's history no doubt has instances of countries with poorer natural assets who have made good and risen by shear endeavour of its people, but the struggle is hard and full of pitfalls and set-backs. The new India, with the heavy accumulated deficit of centuries, has ambitious programme of social welfare of its vast illiterate population. Against this are its prolific natural assets of land, water, power and minerals which if utilized at their optimum potentiality can provide enough capital needed for the work. With the unlocking of this capital the very handicap of a vast teeming population turns into a source of strength through the accession of millions of units of additional man-power. The uplift of the bulk of India's submerged and hitherto uncared for population which lives in 600,000 primitive villages, should be the first charge of her new Rulers. By their uplift is meant not only the oft-repeated slogans about the spread of literacy, hygiene, sanitation and nutrition but also provision of houses, roads and a modicum of the new-world urban amenities, such as mechanised transport, electric lighting and community radio. This may seem a formidable list and may well daunt the staunchest patriot at first, but the charge is no doubt largely off-set by the country's existing and potential assets. Their capacity to provide the wherewithall will only depend on the rate at which they are developed and their judicious exploitation. Here science comes into the forefront, as it is only through the methods of science that the correct mobilising of India's natural resources and their maximum utilization is possible. Modern science is competent to cope with this immense task and finally "deliver the goods"; it has done it again and again in other parts of the world. Political and religious ideologies have grappled with the problem of social amelioration of the masses in India for decades, but with all their high aims and honest endeavours they have only succeeded in complicating the problem. They had no tools for this immense task and the result has been that our natural and material resources have remained half tapped—where they have not been totally neglected—and the mass social stagnation and inertia have remained. The accident. The air is thick with promises about industrialisation for the good of that much talked about individual labelled as the common man. That invitation is a tacit recognition of the fact that promotion of social welfare in free India through the avenue of industrialisation demands that more honoured place has to be assigned to the industry.

The angles of approach to the problem seem to emphasise application of science mostly in the industrial and allied fields. It is this tendency to narrow down science in the process of application, that has made promotion of social welfare difficult, if not well nigh impossible. A fundamental discovery in science, brings in its trail a long set of demands. It shakes at times our long cherished religious beliefs. It demands re-orientation of our economic system. It tends to crack the foundation of our political order. It dictates to us to come out of anti-dated social orders and so forth. We should not therefore be bagged down to consideration of application of science to what at first sight may seem to be its obvious field of application, *viz.*, the industries; though here again it is heart-rending to find the neglect of science in their day to day operations.

The promotion of social welfare by application of science, must take into account this wider perspective whether looked at by a votary of fundamental sciences or the so-called applied scientist whose lot it is to utilise some of the known facts of science in running an industry, or to help grow more food, or promote better health. Without this all out approach, social welfare by application of science will remain an utopian dream.

In the history of march of science, a few facts emerge:—

(1) Between a scientific discovery and its application there is a long gap. Between Watt's watching of the boiling kettle and the application of steam for locomotion to drive the wheels of industry there was a long gap. Between the discovery of Electricity and the advent of what is known as the age of Electricity there has been a still longer interval.

(2) The scientist, as a rule, has been content to make his discoveries but has not concerned himself much with the possibilities of its application or the implications of such applications.

(3) This apathy on the part of the scientist has resulted in the application of science being left in other hands. The actions of these latter have not as a rule been motivated by a conscious desire for promotion of social welfare *i.e.*, welfare of the human community at large. On the other hand the pattern for application, has been designed for providing enormous luxuries for a few and not enough of the essentials for the many. If a comparatively large number has progressively been the beneficiary of a discovery, it is because this pattern could not help it to be otherwise. In this, so-called Scientific Age, when technical triumphs of science are loudly advertised, what has just been stated, might sound as rank heresy. But facts of history cannot be changed by merely wishing them to be otherwise. The Steam Age helped the agricultural land lords to turn Industrial Barons. True, a few more individuals got some more clothings or shoes or this and that necessities of life but it also raised a rew monster—the 'slums' with its attendant evil. The Age of Electricity has not meant less drudgery for the worker, though for the lucky few it has brought in endless electrical gadgets to amuse themselves with.

(4) Finally, the age of Necuclear Energy was heralded with emphasis on its destructive possibilities. Here is one exception where between a discovery and its application, the interval was negligible. At the risk of being dubbed a cynic, one may well ask, was the interval shortened as the intended application was more heinous, more diabolical and more brutal than previously known?

Turn to whatever field of human activity, you may, this pattern of application will stare you in the face. Probably nowhere is this more glaring than in the domain of economics. Nowhere has the failure to harness logic of science been more responsible for bringing in unhappiness and misery.

Take an instance within living memory: In the early thirties of the present century there was a wroldwide depression, with consequent mass unemployment. The warehouses were full of food and other daily necessities of life. Yet men stood on bread line while coffee was burned in boiler and a Chicago merchant staged an eggs-breaking contest. The highest prize went to the man who broke the largest number of eggs. Over-production was diagnosed as the malady. All sorts of crazy remedies like above were suggested and people who were rendered penniless were advised to eat more food, buy more goods, etc.

In less than two decades, afterwards we are told now to eat less, buy less and the new slogan is 'produce or perish.'

While in production methods science can legitimately take pride in its triumph, in the field of distribution of the benefits of production, there has been little use made of its dictates. The result has been that impresion has gained ground that science is a force for the evil and the scientist is the evil genius behind it.

Can the scientist be altogether exonered of this charge? By his apathy or passivity he has been instrumental in allowing not only the denial of the fruits of his discoveries to a majority of the people, but in bringing in positive miseries for them. This misery may be unemployment or insecurity of their very lives, hearths and homes, as has been amply demonstrated in the case of what happened in the two Japanese cities in the last world war.

The need for a more positive, if aggressive, role by the scientist is overdue, if any scheme for social welfare by application of science is to become a reality. Pursue of science for the sake of science will not do. As pointed by Dr. Erdman, Professor of Philosophy at Columbia University at a symposium similar to ours, "Scientists are obligated to regard research from the point of view of world citizens and responsible members of the human race". This is an invitation to the Scientists to come out from the seclusion of the laboratory and to occupy their rightful places of leadership in every domain of life in a community.

The recent formation of the Federation of Atom Bomb Scientists is a step in the right direction. The object of this Association is to prevent misuse of Atomic Energy and thus to avoid the repetition of the grim tragedies that were enacted in Japan some three years back. The Federation has taken upon itself the task of educating politicians and statesmen and the average citizen about the situation created by the discovery of the atomic energy. Inevitably, they speak of setting up a world authority, for the control of this energy. They warn that without this world authority or World Government, the very existence of the human race is threatened, and the need for social welfare by application of science would then vanish for all times.

But the formation of the Federation is only the first step. Many more associations like this are needed to prevent misuse of science in every sphere of human activity, be it industrial, economic, social or religious. But trying to prevent misuse is a negative role. These bodies have to play an aggressive role and to see, that the application is always directed at more positive—the ends being the greatest good not only to greatest number but to every living human being in any corner of the globe. This positive role demands not only a programme for extensive education all round but also demands that some of the points of vantage, from where policies are dictated are occupied by men of science.

To-day the scientists are the greatest creators of wealth. In them therefore lies the greatest strength, even though at the moment it may remain in potential form. To make it kinetic and dynamic is the need of the hour, and it brooks no delay. Whether in war or in peace, those that have the power to mould the shape of things, in the community national or international plane, turn to men of science for the execution of their plans. The key therefore lies with the scientists. It is for them to dictate their terms and specify what this mould should be like. Mere associations of men of science for educating the politicians of the average men will not be enough, for in the race between attempts at mass suicide and true mass education the latter has a habit of being always bogged down at the starting post. Such associations must operate on a more positive and effective basis. They should operate through every community and every country not for securing any sectional advantage for science, scientist, or any country, but for the attainment of that common factor, *viz.*, the good of the human community.

Science has been aptly described as having endless frontier. In this new age of science, it is the moral obligation of scientists to see that in its applications, misuse becomes impossible. They have allowed themselves to be utitised in a Manhattan plan for destruction. They have now to engage themselves in a much harder plan for eliminating sources of conflict, in the process of application of their discoveries. If social welfare by application of science is to become true and real, the logic of endless frontier for science demands an endless frontier for the globe in which the human community

V

MEDICAL AND HEALTH SCIENCES IN RELATION TO SOCIAL WELFARE

Dr. A. C. Ukil, Calcutta.

Health is a major basis of human progress, and its lack is one of the causes that lead to national decay. Other things being equal, good health makes for psysical efficiency, bodily comfort, a sense of well-being, and developes energy, alterness and keenness.

On the other hand, sickness and death bring many evil results, such as poverty, crime, laziness, inadequate output of work, broken homes, hopelessness and despair. The maintenance of an adequate standard of physiological health and fitness, is, therefore, of greatest importance in a free country.

Social conditions react on health and health reacts on social conditions. It will be found that, in most spheres, the deviation from physiological health is related to problems connected with housing, clothing, education, inadequency and adulteration of food-stuffs, domestic environmental cleanliness, water supply and the disposal of sewage, household refuse and manure. Public health, which is a branch of social welfare, is intimately connected with the life and work of the individual, as well as groups.

The average life-span of an Indian is probably the lowest in the whole world (26 years) and our general death rate is 2½ times of that in more progressive countries. If we compare our figures with those in England, it will be found that in India, the death-rate in children between 0-10 years is four times as high as in England and that 50% of this occur in the first year of life. Five times as many infants die in India as in Australia and New Zealand. Maternal mortality due to child-bearing is six to seven times higher than that in England.

Over 50% of deaths in India take place in individuals below 15 years a[illegible]
15% of Indians aged 60 years and above die annually in contrast to 6% in [illegible]
Wales (1938). If the English death-rate obtained in India today [illegible] ...nd over
been 3 million fewer annual deaths and the expectation of life [illegible] England and
years. The death-rate for India seems to correspond w[illegible] there would have
modern public health movement got into its stride in [illegible] would have been above 60
[illegible] ...n English figures before the
[illegible] the 60s and 70s of the last [illegible]

In a recent survey in rural Bengal, it was seen that 12% of the population were unwell at any given time and that for every death that occurred 800 man-days were lost due to sickness. The disease rate was found to be the highest in infancy (96%), quite high in the lower age groups (44% among school children) and gradually decrease with age. 44% of the population suffered from clinically recognisable malnutrition. Thus poverty (as represented by poor educational and economic status of the population, uneconomic holdings, unhygienic housing and unsatisfactory environmental conditions) led to sickness and sickness aggravated poverty. The average duration of disabling illness was found to be 50 days per sick person or nearly 20 days per head of the population, a colossal economic loss to the country. When only 4.5% of the population get the benefit of protected water supplies, it is futile to expect the elimination of bowel infections like, cholera. The Bhore Committee's description of housing conditions in urban and industrial areas makes depressing reading. The backwardness of India in the proper evolution of public health must be accounted for either by the progress of science not being applied to the prevention of diseases as has been done in advanced countries, or to a wrong application of the same.

It has been seen in other countries that the raising of the standard of living with regard to food, clothing, housing, education and social security has eliminated 70% of the diseases. Modern public health, which is an integrated part of social services like education, agriculture, animal husbandry, co-operation, industry and health insurance, has to be paid for. Socio-economic advance is, therefore, inevitably linked with the reduction of illnesses and improvement of health. We have shown elsewhere that the income per capita of the population has to be increased four-fold, if we aim to give the people a basic standard of healthful life.

India is bound to be industrialised. When a country changes from agricultural to industrial economy the social structure undergoes radical changes. No improvement in health can be achieved *without the simultaneous development of the programme of national reconstruction* in the field of agriculture, animal husbandary, education, industry, housing, improvement of communications and social assistance, factors which are essential for improving the standard of living of the people. Without the realisation of an *integrated development,* the improvement of health may be a fleeting objective, at least in the rural areas. The activities should start from the villages, which represent the base of the pyramid and will gradually develop to the top or apex of the pyramid. The utilisation of the time and energy of the landless labourers and villagers with small holdings and the proper correlation between agriculture and industry and between the cottage and large-scale machine industries are important consideration for a co-ordinated planning. It has been stated that such an integrated development will be facilitated by the establishment of Multipurpose Co-operative Societies, to meet the requirements in the different spheres of social activities. But unless there is a *pilot-centre* for demonstration, co-operation and technical supervision in each co-ordinated area, the experiment is likely to meet with failure. As the State must ultimately provide a social machinery to ensure the maintenance of health of the people, the State should carefully consider how to plan the progress. Mahatma Gandhi's "Samagra Gram Seva" scheme might be very usefully fitted into the programme. Health planning must be an integrated component of total national planning.

It has already been stated that India stands, at the present moment from the Public Health point of view, where Great Britain stood 100 years ago, U.S.A. stood about 75 years ago and Russia stood before the Revolution. The lack of a scientific outlook, inadequate investigations by the administrative authorities in developing suitable methods of organisation and the lack of a national policy of co-ordinated planning have been responsible for much of India's backwardness. It is a matter of great pity that our hard-earned freedom has not either acclerated the progress not has it changed the outlook and methodology of administrative machinery. Things will continue to remain very much the same unless a revolutionary outlook is developed and a forced march is undertaken.

VI

APPLICATION OF PHYSIOLOGICAL PRINCIPLES IN THE IMPROVEMENT OF THE EFFICIENCY AND WORKING CAPACITY OF MAN

Dr. B. B. Sarkar.

Physiology Department, (Calcutta University).

There is an aspect of Physiology in which the application of its principles will benefit the nation. Free India is busy making plans for rapid progress in many spheres of national activity. The success of these endeavours will depend to a large extent on the efficiency of the personnel engaged. By efficiency is meant sound health and maximum working capacity, which is some thing more than absence, and it depends on physiological principles. The standard of efficiency has to be raised to increase production.

The activity of man is the result of delicately balanced and rapidly adjusting reactions, which is maintained inspite of wide variations and frequent fluctuations. There are various factors, both intrinsic and extrinsic, which influence and modify the working of the body. If these factors and their actions are known, attempts could be made to adjust or regulate them to ensure optimum physiological activity.

The problems in this connection are varied and variable. They include amongst others, for instance special study of and researches on Metabolism, Nutrition and Dietetics, on Physiology of Exercise, on the regulation of Body Temperature and the influence of Heat and Cold on activity, on Industrial Physiology and on Aviation Physiology. Solution of these problems will benefit every one in the land, in every sphere of activity.

There has been in recent years, a considerable advance in our knowledge regarding the influence of these factors on the efficiency and the working capacity of man. In India serious attempts should be made to study these important problems for improving the human factor in all spheres of activity.

To give effect to this proposal some planning is necessary. For systematic study and research in these problems, arrangements have to be made for (*a*) Properly qualified staff of research workers, (*b*) Properly equipped laboratories, equipped for the special type of work, (*c*) Co-operation between the laboratories and institutions and concerns connected with the problem, (*d*) Sufficient funds for study and research.

The work is almost entirely physiological and physiologists trained in the methods of biochemistry, biophysics and histology will be necessary for this. Physiological and biochemical departments in the different parts of this country, will be able to supply the trained personnel. These laboratories will also be able to take up the solution of many of these problems, provided they are helped to do so. India will require a large number of such institutions in the different parts of this vast country, to successfully solve these diverse problems. The Government and the Universities should take up this matter without delay, and help this country in its march towards greater achievements.

VII

ORGANISATION OF SCIENTIFIC EDUCATION

Prof. A. C. Banerjee, Allahabad.

A) *General*:—

(1) Two sets of values can be associated with Science. One, the value of science as such when it is regarded as the source of knowledge or the repository of truth. The other value is the betterment of the condition of mankind when science is applied to technology on which the material welfare of humanity depends.

(2) Science is a great social force in as much as it has taught the right mode of approach to truth and to proper solution in tackling the social problems. Science has got at least one advantage over history or literature in as much it is a more powerful exponent of reason and a staunch adherent to true rationalism.

(3) Due to want of facilities, absence or opportunities and lack of proper guidance which the youth of our country experiences, many a talented worker is destined to wither away without getting any chance of revealing themselves.

(4) Establishment of "National Science Foundation" on the line of the Science Foundation in U.S.A. is essential. Such a Foundation should also support basic research in addition to applied research connected with technical and industrial concerns. Social sciences which include statistics, business organisation, industrial management and psychology should also form a part of the scheme to be sponsored by the National Science Foundation. Due to rapid industrialisation Social Science has a very useful application in the operation of any large scale enterprise of modern times.

(5) Reliable educational statistics should be obtained so that a true educational pyramid which can give a complete statistical picture of the present educational development of the country may be obtained.

(B) *In the Universities*:—

(1) Space at the disposal of University Laboratories for Under graduate classes, Post-graduate classes, and Research workers.

(2) Equipment for Under-graduate classes, Post-graduate classes and Research workers.

(3) Chemicals and other materials required for Post and Under-graduate students and other Research workers.

(4) Construction of University Museums (Zoological, Botanical, Archaelogical, Anthropological, and Geological).

(5) Scientific Expeditions and Surveys.

(6) Scientific and technical books and periodicals.

(7) Close relation between Technological and other Scientific Research Institutions.

(8) Astronomical Observatory attached to Universities and co-ordination with other Observatories.

(9) Close co-operation between Universities and other Scientific bodies like National Institute of Sciences, National Academy of Sciences, Indian Academy of Sciences and other learned Scientific Societies.

VIII

IMPORTANCE OF HIGHER EDUCATION FOR SOCIAL WELFARE

Prof. M. N. Saha, Calcutta.

Since August 15, 1947, India has been free to shape her own destiny, and her success will depend to a large extent on her capacity to organise education for the people on a proper scale for education is the preparation of the individual for the service of the community. A Government of India communique appointing the University Commission puts the point very clearly as follows:—

"The importance of primary and secondary education in a demoracy is obvious. Their quality, however, depends in the ultimate analysis on the quality of educational leaders, and these can be produced only by a suitable system of higher and University education. Provision of extended facilities for higher education is, therefore, necessary for the satisfactory functioning of democracy. A vast change has taken place in the country with the achievement of independence. New vistas have open which necessitate a survey of education at all stages. The interests of the country require vast programmes of expansion in Agriculture, Industry and Commerce which, however, can be carried out only if a sufficient number of highly trained executives and artisans, craftsmen and skilled labour of all grades and types are available. The problems of Defence cannot be satisfactorily solved without the existance, within the country, of all facilities for technological and scientific studies of the highest order. Extension of the boundaries of knowledge and research is also essential if we are to improve the quality of education which is now available to us. There has been no detailed examination of the existing Universities and their work since the report of the Sadler Commission in 1917. All these factors demand a comprehensive enquiry into the question of our University and higher education."

The terms of reference are very extensive and well thought out. The terms of reference of the Commission will be to consider and make recommendations in regard to:—

(*i*) The aims and objects of University Education and Research in India.

(*ii*) The changes considered necessary and desirable in the constitution, control, functions and jurisdiction of Universities in India and their relations with Governments, Central and Provincial.

(*iii*) The finance of Universities.

(*iv*) The maintenance of the highest standards of teaching and examination in the Universities and Colleges under their control.

(*v*) The courses of study in the Universities with special reference to the maintenance of a sound balance between the Humanities and the Sciences and between pure science and technological training and the duration of such courses.

(*vi*) The standards of admission to University courses of study, with reference to the desirability of an independent University extrance examination and the voidance of unfair discriminations which militate against Fundamental Right 23(2).

(*vii*) The medium of instruction in the Universities.

(*viii*) The provision for advanced study in Indian culture, history, literatures, language, philosophy and fine arts.

(*ix*) The need for more Universities on a regional or other basis.

(*x*) The organisation of advanced research in all branches of knowledge in the Universities and Institutes of higher research in a well co-ordinated fashion avoiding waste of effort and resources.

(*xi*) Religious instruction in the Universities.

(*xii*) The special problems of the Banaras Hindu University, the Aligarh Muslim University, the Delhi University and other institutions of an all-India character.

(*xiii*) The qualifications, conditions of service, salaries, privileges and functions of teachers and the encouragement of original research by teachers.

(*xiv*) The discipline of students, hostels and the organisation of tutorial work and any other matter which is germane and essential to a complete and comprehensive enquiry into all aspects of University education and advanced research in India.

It is to be hoped that the Commission will be able to evolve a proper system of University education in accordance with the directions given above, but it will probably be not out of place to point out some features of present University organisation.

University Education including all education is at present a provincial subject, only the three Universities of Aligarh, Banaras and Delhi have direct contact with Government of India. In the Draft Constitution of India, it has been proposed to continue this system.

The Education Ministry, in appointing the Universities' Grant Committee has however recognised that all Universities of India should receive monetary aids from the Centre.For the terms of reference are as follows:—

"To make enquiries and recommendations regarding:

(*i*) the lines on which the Universitives should develop,

(*ii*) the additional amounts in the forms of grants-in-aid from public funds required for these, and

ii) the co-ordination of their activities with a view to avoiding unnecessary overlapping."

Free India has now a National Government, and it is but natural that the New Indian U. G. C. has been invested with power to look after the financial needs of, and to formulate plants for, University education that would be adequate to national needs. According to the terms of reference, the National Government had crearly done away with the fiction of "Central Universities", and recognised clearly that as the future administrators, public servants, scientific and technical men—in fact all the personnel needed to run and develop a modern state had to be recruited impartially from all parts of India, all University Education and higher research should be their charges; and it would be hazardous for the unity and development of India, if University Education was left entirely to the fissiparous policies of provincial legislatures and caprices of the local party politics. It is, however, necessary to ensure at the outset that the Indian U. G. C. may not be satisfied with mere identity in name and similarity in the terms of reference with those of the U. G. C. in Great Britain, but that it may be as conscious of the nature and scope of its responsibilities, and as earnest and thorough in discharging the same as the British U. G. C. It is to this end that we publish elsewhere in this issue on article on the function and working of the British U. G. C. and the expansion of University education in that country brought about through its efforts during the last 30 years. We propose now to review some of the lessons brought out in that study with a view to their adoption by our U. G. C.

The problem of University Education is indeed very difficult and intricate in India, because of the vastness of the country with its much larger population, the existence of autonomous governments in the provinces simultaneously with a Govt. at the Centre, and its much more slender finances. The needs of the country for education at the First Degree and higher stages must be carefully estimated, both on a short term and a long-term basis, and this need must be met by a judicious and economical distribution of available provisions. It has further to be ensured that these provisions are made available to those of our young men who are most qualified to profit by them. The cost of all these provisions must be allocated between the Centre and the Provinces on the one hand, and between local civic bodies and the State on the other hand. To undertake these enquiries the Government of India has appointed a Universities Commission. But after this Survey is over, and the form of university education most suited to the requirements of the nation and the genius of its people, has been formulated, and the measure of State aid necessary in relation to the number of University-trained personnel required for the country, has been estimated, it will be the duty and privilege of the Indian U. G. C.—may be aided by provincial Committees—to carry out the programme, and to ensure that India adopts a modern system of University education on a scale which will be comparable to those—operating in leading countries of the West.

To sum up: Our recommendation is that the University Grants Committee can discharge its functions in a way consistent with the new educational responsibilities of free India, only if it is reorganised on the following lines:

(1) University Education throughout India should be in the Concurrent List of the Draft Constitution of India.

(2) The Central Government, as well as the States, should set apart a certain percentage of their revenue for education in general, and a certain part of it should be reserved for University education. This should be incorporated in the Draft Constitution.*

*The Chinese Government has a clause in its constitution that 15 per cent of its revenue should be spent on Education. Contrasted with that the Central Government of India spends less than 1 per cent of its income on Education; though some of the Provincial Governments of India spend liberally on educattion, *e.g.*, the Government of Bombay which spends 18 per cent, other Governments are very economical on education. The West Bengal Government, entirely composed of members elected on Congress ticket, spends only 6½ per cent and we are told on high authority that of this, a substantial amount is going to be "Unspent Balance". The present West Bengal Govt., has thus outdone the League Govt. in killing education, for even the League Government spent 12 per cent. While the West Bengal Government has been extremely economical on the salaries of starving teachers belonging to primary, secondary, collegiate and University rank, it has been extremely liberal towards its Secretariat staff.

IX

A DECLARATION CONTAINING THE PRINCIPLES OF A CHARTER FOR SCIENTISTS

Prof. J. M. Sen, Calcutta.

The Committee on Science and its Social Relations instituted by the International Council of Scientific Unions, at its meeting held at the UNESCO House Paris, on the 15th & 16th June, 1948, had drawn up certain principles of a Charter for Scientists which could be summarised as follows:—

"The prominent position held at present by science in society, and the rapid transformation of the world through the application of science, carry with them for scientific workers special obligations over and above the ordinary duties of citizenship. Besides this the scientific worker has special responsibilities since he or she has the possibility of obtaining information not readily available to the average citizen. It thus becomes the duty of the scientist to:

(*a*) maintain a spirit of frankness honesty, integrity and co-operation, and to work for international understanding;

(*b*) consciously examine the measuring and purposes of the work that he or she is performing;

(*c*) when in the service of others enquire into the purpose for which the work is being done and the moral issues that may be involved;

(*d*) promote the development of science in the way most beneficial to mankind and exert his or her influence as far as possible to prevent its misuse;

(*e*) assist in the education of the people and the Government in the purposes and achievements of science.

In order to fulfil these obligations it is necessary to claim certain rights for scientists, the principle ones of which are:

(*i*) freedom of publications and the utmost freedom to discuss one's work with other scientists;

(*ii*) economic security and the right to participate freely in all activities permitted to all citizens; and

(*iii*) the possibility of obtaining information about the purposes for which his or her work is being done."

The Committee on Science and its Social Relations has also undertaken an enquiry on the importance of Science and of scientific co-operation for peace. The aforesaid Committee has invited the opinion of the Indian Science Congress Sub-Committee on Science and its Social Relations on the following two main questions:—

(*i*) In which measure do the methods of international scientific work contribute to the creation of an international spirit and to the maintenance of peace?

(*ii*) In which ways could scientific organisations and scientists intensify their activities for the maintenance of peace?

The aforesaid Committee has also raised the question of giving attention to *man* himself as the fundamental unit of Society and therefore has asked everybody to consider three principal aspects of social relations of science, *viz.*—(*i*) The scientist before society; (*ii*) The changes introduced in human societies through the technological development of science; (*iii*) The antagonism between biological order and social order.

Professor J. M. Sen in his remarks stated that a careful consideration of all the above questions was necessary for the future welfare of India. He further invited the attention of all to an editorial in the Journal of the Indian Chemical Society (Vol. of an international federation should take an oath in the words of Dr. Weltfish, as follows:—"I pledge myself that I will use my knowledge for the good of humadnity and against the destructive forces of the world and the ruthless intent of man, and that I will work together with my fellow scientists of whatever nation, creed, or colour, for these our common ends."

X

In the discussion which followed Sir Santi Swarup Bhatnagar, spoke on the Present Organisation of Scientific Activities in the country; Sir Jnan Chandra Ghosh spoke on the Industrial Organisation of the country in relation to Social Welfare; and Dr. J. N. Mukherji spoke on the Agricultural Sciences in relation to Social Wefare. In conclusion Sir K. S. Krishnan summed up the proceedings by emphasizing the need for holding such symposium for focussing the attention of the scientists to the various aspects of scientific of work for social welfare which they could do in India.

TRAINING IN INDIA FOR PROFESSIONAL CAREERS IN THE FIELD SCIENCES*

(SECTIONS OF GEOLOGY, ZOOLOGY, BOTANY AND ANTHROPOLOGY)

DR. S. L. HORA, opened the discussion.

In opening the discussion, Dr. S. L. Hora regretted the absence of Dr. W. D. West who had sponsored and arranged for this discussion to be held. He then referred to the publication "An Outline of the Field Sciences of India" and stated that India abounds in problems requiring field investigations. He stressed the value of field studies in the application of existing knowledge to human use and wanted the university system of taking the students out on excursions to be systematised and made more effective. He expressed very strongly that training abroad in the initial stages may even be harmful to the country, for the first requisite of any such training is to know the problems and then one may apply the experience of other countries for devising methods to deal with them.

Referring to the methods by which such a training could be given in India, he explained the value of the following:—

I. Visual Education.
  (i) Museums, National Parks, Demonstrations, Charts, Films, etc., etc.
  (ii) Excursions and outings to places of scientific interest.

II. Scientific Departments and Institutions of Government.
  (i) Closer collaboration and co-operation between Universities and Governmental Science Organisations through provision of facilities for students, recognition by the Universities of Government Departments as institutions for post-graduate research for degrees, exchanges of personnel and institution of Studentships or Fellowships tenable at Government Departments.
  (ii) By assigning Field Problems for Research Degrees.

III. Integration and Co-ordination of field sciences through meetings and researches on borderline sciences.

In conclusion, Dr. Hora pointed out that field sciences studied in the field lose all their hardships and become more and more fascinating as one develops the powers of observations. All modern disciplines of the biological sciences, such as Ecology, Bionomics, Plant and Animal Geography, etc., are based on field training.

PROFESSOR C. MAHADEVAN, (Waltair).

One of the most neglected aspects of the field sciences in general and of geology in particular is the absence of adequate facilities for the field training of those receiving education in these sciences. Excursions which are compulsory for such subjects as geology in all the universities are of too short a duration to be of any tangible value. The aim of these excursions is to take the students to places of academic and economic interest; by its nature it can only be a mere introduction to the study of the subject. Teachers of field sciences are usually persons who had not undergone the discipline of real field work with an eye to the practical and economic sides of the subject. In the first place, a teacher handling a field science like geology must be required to spend at least a year in every five years in the field, in collaboration with the Geological Survey or Mines officers. Officers of the field surveys like the Geological Survey also need to spend a similar period in University centres to enable them to develop an academic outlook side by side with their practical bias of approach to scientific problems. Therefore the exchange of personnel between the Surveys and the Universities can be easily arranged. In addition to this, a teacher of geology must be compulsorily required to spend a month in the field every year either by himself or with senior and research students. These will go a great way to give a new orientation to geological education.

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*Symposium arranged by Dr. W. D. West, Calcutta.

Coming to the training of students in the field work, the present facilities, though an improvement on the past, are unsatisfactory on account of the following reasons:

Every aspirant graduate for the field training, *if he is selected,* has to pay the Government a fee of Rs. 250|- besides bearing his touring expenses from his home to the place of training and for his living etc. He is clubbed with the junior officers of the G. S. I., who are earning members and are paid T. A. for the training. The Universities with their crippled finances are unable to support the student. In effect only very rich persons can afford the training that is now available. The least that the Government can do immediately is to give field training free to those qualified and desirous of receiving it and to give concessional fares by railway to reach the camp from their homes or Colleges, which are often very distant. A good part of the time is now spent in the field training by G. S. I. in teaching topographic surveying. This must have been taught to the students as a regular course before graduation as is being done in the Andhra and some other Universities. Every saturday, during the College term must be devoted to survey work and field mapping. The instruction in the field training by G. S. I. has to be of a more advanced type. This can be possible if the elementary aspects are completed before graduation and Honours stage.

In the Andhra University, the new rules require all geology students to spend, besides the usual excursions of 15 to 20 days every year, a term of practical training in geological topographic surveying and in mining and quarrying, during the long vacation for periods varying from 4 to 6 weeks, according to the year of study. To give practical effect to this new rule, the Government through the Geological Survey, Mines and Bureau of Mines Departments, must afford the facilities and subsidise the scheme with a generous award of scholarship to poor deserving students. Unless our education in the field sciences in general and in geology in particular is re-oriented, we shall not be able to sustain the Government and the Industries with the right type of technical personnel to do an advanced kind of work. The scope of activities of the geological survey is in urgent need of revision and expansion, with the changed political and consequent economic condition. A varied programme of field work and laboratory investigations capable of utilising different grades of trained personnel can be easily divided to get maximum man-power-talent benefit to the country. Leakage of scientific talent into other fields for want of suitable opportunities is a problem, the magnitude of which hardly seems to have been yet realised. Money spent by the Government in the practical training of personnel in field sciences will be a national investment and asset.

PROF. NIRMAL KUMAR BOSE, Calcutta.

1. Mr. N. K. Bose endorsed Dr. Hora's suggestion that there should be move co-ordination in research. An anthropologist studying human society needs the help of a botanist, a zoologist and a georapher when he tries to find out the relation between man and his environment. So it would be a great help if *joint excursions* could be undertaken by various depts. of a University.

2. The season for field work is from *Nov. to about Feb.* If some arrangement would be made in the Universities so that the students & teachers could spend these *months in the field,* it would be of immense help. If this is not to be counted as a period of study, it can be treated as a period of vacation; and the summer vacation curtailed or done away with altogether. Students of the field-sciences can very well work in the laboratory all through summer as a compensation for the field-vacation which they have received in winter.

3. Students may also be asked to submit report of some field work, which they undertake *on their own initiative* as part of their practical work. Of course, there should be proper guidance.

4. Lastly Mr. Bose endorsed Prof. Mahadevans' remark that for proper field training, it was not merely necessary that there should be a good programme, but also a good leadership. A *good leadership* alone can create the atmosphere where the talents of the students find their best exercise.

DR. M. L. ROONWAL, (Banaras Cantt.):

In my Address before the Zoological Society of India at its Patna Annual meeting in January 1948 entitled "On Zoological Standards and Progress' (*J. zool. Soc. India,* 1 (1) Jan., 1949), I had given a list of the twelve major disciplines of Zoology. Some of them are static like Morphology, others dynamic like Ecology, Zoogeography and Natural History. If we examine the graduate and post-graduate teaching in our Universities, we find that the teaching is confined to the static disciplines such as morphology, cytology and embryology, and the dynamic disciplines are excluded. Some of these latter (*e.e.,* genetics) are to be found in the curricula, no doubt, but in actual practice, the lectures on them are few and inadequate and practical demonstrations either negligible or totally wanting. Such disciplines as ecology and zoogeography are taught nowhere.

When these students, with a good knowledge of theory and of the static branches of zoology, join the field departments like the Zoological Survey of India, or the various field entomological schemes (*e.g.,* the Locust Research Scheme) run by the Indian Council of Agricultural Research, we find that they are completely at sea. All of them, without exception, hanker, at least for the first year or two, for purely morphological work which they can comfortably do in the laboratory room. In due course it is possible to "break in'' some of them, but others resist field work to the very end and are failures.

As a result of the experience of nearly 17 years of field-work, it seems to me that the major causes of failure, and the remedies, are as follows:—The students do not have the faintest idea of what "field research" is, and what are its scope, problems and achievements. He is ignorant of the fact that field research can be as exciting and creative as laboratory research, perhaps even more. He does not know, for example, that such classical advances as the Darwin-Wallace evolutionary theory of natural selection was put forward by these two men as a result of field research primarily. Or, that the problem of the fluctuation of animal numbers (or populationdynamics, as it is concisely known), which is of vital importance in the spheres of the control of agricultural and forest pest, of the epidemiology of animal-borne diseases and in the development of fisheries is primarily a field problem.

Let us, therefore, agree to do something positive and substantial is giving a field bias to zoological training in Indian universities which are the primary sources of recruitment of future personnel to our scientific institutions. I would suggest that we should recommend to the Inter-Universities Board and to the University Enquiry Commission of the Government of India, now sitting, to give their earnest attention to this problem. Courses in the field sciences should be opened forthwith. So far as Zoology is concerned (and this will probably apply also to Botany), the introduction of courses in the following field disciplines is necessary:

1. Ecology (with special reference to Population Studies).
2. Evolutionary Biology (including Evolutionary Genetics and Evolutionary Systematics).
3. Natural History.
4. Biological Statistics.

In all these courses the greatest emphasis should be laid on field work.

There is a certain urgency about this matter. It happens that the disciplines mentioned above play a more direct and rather more important role in national economy than the static disciplines of morphology, etc. They should, for this reason, find a prominent place in any programme of national development.

In the end I should emphasize that by my advocacy for the introduction of the field disciplines in our university courses it should not be understood that the older disciplines such as classical systematics and morphology may be neglected. We cannot indeed afford to do so any more than an engineer can afford to neglect the study of the machine-parts at rest.

DR. KALIPADA BISWAS, (Calcutta).

There exists enormous scope of research in field sciences from Botanical point of view. Vast areas lie yet unexplored. We are to work out these unknown and little known regions in India. The results will be of greatest importance in solving many intricate problems regarding distribution, migration, ecological variations and so on and so forth.

There are about 16,000 species of flowering plants recorded from India and these do not include the large number of cryptogamus. All these will have to be worked out. There is therefore vast opportunities before us in field science research.

As regards applied side I should say that we should confine ourselves to pure research. I donot minimize the enormous prospect of working out our medicinal and economic plants. We have Fungi as Antibiotics, Lichens are of considerable medicinal and economic value, the importance of sphynum moss as antiseptic bandages is well-known and so on. These applied sides of research may better be tackled by those who are interested in applied side of the question of investigation in field sciences.

There is no dispute with regard to the all round investigation of field sciences. The Geolographers, the Geologists and others need not have any misapprehension that their aspect of the work will be neglected. Nor there is any room for complaint against the Government or the University administration. The Govt. is now our own Govt. and there is hardly any room for the separation of these two aspects of educational administration. If the Govt. or the University fail to take up what we need for scientific development we can easily censure them. The most important point, I want to stress is now to draw up a comprehensive plan for an all round research in field sciences, and with a view to working out such a plan with success as it deserves—we Biologists, Geographers, and other scientists all should work in a team as members of one great family of field sciences.

B. K. DAS, (Hyderabad Deccan).

1. Field Zoolozy should be made compulsory in our University Curricula, which is essential for the grasp of zoolozy as whole.

2. Generous grants should be forthcoming both from the University as well as from the Govt.

DR. R. DUBEY, Allahabad.

Everyone is agreed about the need for field training. The problem is one of method of providing this training. The main difficulties are:—

(*i*) Finance.

(*ii*) Time Table Arrangement.

(*iii*) Time for outdoor work.

(*i*) Most of our students are poor and cannot afford the expenses. The Govt. must, therefore, arrange for training camps on a large scale in different parts of the country where Govt. Depts. and Universities must provide direction.

(*ii*) These camps should be organised during winter and the winter vacation should be provided for in the Time Tables of all Universities.

(*iii*) As (*ii*) above.

CAPTAIN AMAR NATH KAPUR.

I. Stages in the development of the science of geography were class-room, Laboratory, and field. Its various branches such as Physical Geography, Economic Geography, Mapwork and Surveying, etc., entail field work.

(*a*) Study of soils (as influenced by underlying rock and climate) as influencing crop productions, soil erosion and exhaustion and remedies. This can best be utilized in setting up Land Utilisation survey of the country. Geographers are very suitable for this type of work. In England the Director General of Land Utilisation survey is a Geographer.

(*b*) Study of water table; River Physics comes under it also.

II. Surveying and map drawing—Geographer handles all surveying instruments —can draw topographical maps including contouring. He can do well in the survey parties and can draw more accurate maps than an illiterate draftsman. Excursions should be arranged where students of geography can use survey maps and records where changes have occured since the last date of survey.

III. Geographer handles meteorological instruments and records weather phenomena. He goes beyond and studies general principles of forecasting. A Geographer can be very useful in Meteorological survey where he can handle all the processes from taking readings to drawing maps and forecasting.

IV. This Science Geography—needs encourgement from the Govt. and the other sciences for the full play and use of its activities in various branches for coordination of their work.

V. More funds should be given by University for excursions and Geographers' survices should be utilised in departments of Feld Sciences.

PROF. A. C. JOSHI, Amritsar.

The greatest handicap in the training of students in field botany is the absence of qualified teachers. Many teachers are quite unfamiliar with the names of plants even of their immediate neighbourhood and consequently try to shun botanical excursions. This can be remedied by the teachers spending a few months occasionally at a large herbarium and doing some taxonomic work. The university and college authorities should encourage this.

Training in field work should begin not at the post-graduate but at a very early stage, even at the school stage. It must form a part of the studies of intermediate and undergraduate students. For this purpose handy local floras are absolutely essential and attempt should be made to write these at an early date for every district which has a university or an important college.

The teachers must see that students properly identify the collections made during excursions and write short reports on them. Suitable specimens from the collections should be added to the local herbarium and the students made to feel that they are thus contributing to the advancement of science.

There must be a botanical garden for every university town and for every large city and regional herbariums should be established for the identification of specimens.

Summer schools should be organised at hill stations during the summer vacation, where post-graduate students and teachers from different parts of the country could gather and do field work.

UPGRADING OF THE TEACHING OF PHYSIOLOGY

(*Section of Physiology*)

Dr. B. B. Sarkar, Calcutta presided.

Dr. B. Narayana, Patna, opened the discussion.

Before upgrading the teaching of Physiology, it is necessary to improve the teaching of the subject at the Matric and Intermediate stage so that sufficient number of students may get interested in the subject and may be available for higher studies and research. The medical college physiology departments in co-operation with the universities concerned should be so framed as to enable the students to go for a B.Sc. degree as soon as he passes the Inter M.B.B.S. Exam.

An upgraded department of physiology in a medical college should be equipped for postgraduate teaching and research independent of facilities provided for medical examinations. A medical graduate with interest in physiology could join the Dept. of Physiology and work for the M.Sc., or Ph.D. degree—if facilities are available and the university regulations are so framed as to permit a medical graduate to work for a Doctorate degree even without a science degree.

Prof. Narendra Mohan Basu, Calcutta.

Physiology is a tripod science of which the 3 legs are Physics, Chemistry and Anatomy. If, therefore, physiology teaching is to be upgraded, students should have an adequate knowledge of these 3 subjects. It thus becomes necessary that special courses in chemistry and physics be arranged for students who would go in for higher teaching in physiology. Similarly there should be facilities for training in anatomy to students of physiology in non-medical institutions. If modern researches are followed, it would be seen that the application of chemistry and physics to solutions of problems of physiology are not only more numerous than before, but have become essential. It is the sub-microscopic structure of a cell which regulates its activities. To understand this structure, a deep intimate knowledge of some aspects of chemistry and physics is necessary. Naturally, therefore, it is not possible for physiologists to probe into the secrets of cell activities, unless they are familiar with some techniques of physicists and chemists.

A point to be noted in connection with these discussions is that no steps are taken for giving effect to the conclusions or resolutions arrived at or carried. It is hoped that the Executive Committee of the Science Congress will take up these resolutions with the proper authorities, so that these resolutions do not remain mere paper resolutions.

Prof. S. M. Banerjee, Cuttack.

1. The Medical Colleges in India should be utilised for Physiology in the B.Sc. Pass and Hons. courses of University. The other subjects may be taken up by the pure Science Departments.

2. The Physist Department of Medical Colleges may be utilised for M.Sc. Courses.

3. The Physiology Departments of Medical Colleges should have (*a*) Some research beds in Hospitals, (*b*) Some biochemical work of the Wards, (*c*) Electrocardiographic Department so that researches in applied physiology may be taken up effectively.

4. There should be some concessions to graduates in physiology during their admission to Medical Colleges.

The Discussion was resumed on the Second day when.

Dr. S. Datta, presided.

Physiology in Veterinary Colleges and in the Indian Vety. Res. Institute is largely concerned with the orientation of veterinary work in animal health as opposed to veterinary pathology. Vety. profession is in urgent need of securing facilities for training in physiology. The study of physiology as a pure basic science is to be recommended. Those possessing vety. diplomas only (without university degrees) should be given opportunities of studying advanced physiology.

DR. N. P. BENAWRI, Darbhanga.

'It has been suggested by some speakers that higher studies in physiology should be developed in Science Colleges and that the teaching of Anatomy & Physiology be shifted from medical colleges to science colleges. I beg to differ from such a view and for very good reasons too. Physiology for a medical student should from the basis for his further studies in medicine and surgery also, hence it is necessary that applied aspects of the subject be duly emphasized, which can be done by a medical man alone who has specialised in physiology. At the same time the clinical material of a medical college hospital should also be available for the physiologist for demonstration to the students to emphasize the practical application of the physiological knowledge. Hence the teaching of physiology to students of medicine should be undertaken by medical men who have specialised in physiology and at a place where clinical material can be easily obtained.

I further agree with Principal B. Narayana that the M.Sc. Ph.D. & D.Sc., degree's regulations should be so changed that a medical graduate may proceed to study for such degrees without a basic science degree as is the custom in foreign countries.

There should be some research beds in the wards to which Physicians and Surgeons should admit only such cases as are needed for physiological researches which should be carried on from time to time. Their treatment, would, of course, be carried on by Physicians and Surgeons.

PROF. S. N. MATHUR, Lucknow.

Regarding the upgrading, I feel that instead of naming any subject it would be desirable that an institution or a College where researches are being done—and it may be taken that researches done in the medical Colleges or other institutions of similar nature they all will have physiological bias or basis, as physiology can never be divested from any such research—should be upgraded as a whole and put under the charge of a competent person as its Director. To this research department people, not only from physiology, but from other allied departments will be attracted and there will be possibilities of a sort of team work. When any research is done on any subject it is always felt that if persons competent in allied branches of science be associated with that, a more wholesome and better research on different aspects, which always crop up, is made possible.

Further, whatever Professor Narayana has said I entirely agree with him.

I may add that a student who passes in Physiology of the medical curriculum should be permitted to proceed to the highest degree in physiology based on research and if there should be any technical objection, suitable regulations may be framed.

K. MITRA, (New Delhi).

It is high time that we take up very seriously the valuable suggestions made by my friend, Professor B. Narayana in his opening remarks. Our learned president in his thought provoking address yesterday, has made out a strong case for better methods and newer avenues in the teaching of Physiology. Reference has also been made to the Upgrading Committee appointed by the Ministry of Health. Not being an accredited representative from any university or research institute I feel diffident to make any comments on the aspects of higher research in Physiology, referred to by the previous speakers.

For the proper working of certain sections of nutritional programme e.g., proper feeding of patients in hospitals, school meals, canteens at works, industrial health visiting, etc., the respective administrations would need newer type of trained technical personnel and in very large numbers. I may make a casual mention of something I noticed in Leeds whilst going round university teaching centres in the United Kingdom. The University of Leeds have from October 1946, remodelled their syllabus of teaching Physiology for the B.Sc. degree to suit the post-war requirements of that country. After certain amount of preliminary training in the subject, the curriculum provides for a specialization in three different subsections of Physiology (*a*) embryology and histology (*b*) nutritional physiology and (*c*) works physiology. With the contemplated development of dietetics and industrial health programme in our country, we need quite a large number of people trained either as nutritionists, dietitians, industrial nurses or industrial health visitors. If only our universities would provide for the basic training in Physiology the other necessary technical training can be arranged for in the medical colleges, sanitary schools, nursing colleges, etc.

Before I close I would particularly like to make my comments on a point raised by my learned friend Professor S. M. Banerjee from Cuttack. He has demanded a few beds in the hospital to be reserved for the Professor of Physiology. I am afraid I cannot support this proposal for two specific reasons: the first and foremost being that treatment of cases in hospitals and infirmaries be better left to the physicians who have specialized on the subject and secondly because such a tendency might encourage the pharmacology or the biochemistry departments to ask for beds attached to their respective Professors for treatment and research. However, layman as I am from the Government office, it is a bit difficult for me to comprehend why the professors of Physiology or Pharmacology or Biochemistry cannot work in close collaboration or probably closest collaboration with the experts on the clinical side for purposes of research on the diseases as also the actual treatment of patients. This alternative might solve the difficulty pointed out by Dr. Banerjee in a quicker, easier and more satisfactory manner serving the best interests of all concerned. Collaborated research is almost an unknown practice in this country but that should not be a bar for developing the same provided the collaborators themselves are inspired by the ideal of service and search for truth.

DR. M. L. CHAKRABARTY, Calcutta.

I have listened with interest to the talks given by the learned speakers on a problem which now in free India is an exceedingly important one. In fact, Physiology has virtually remained so long within the domain of Medicine, but now with the achievement of independence there is a growing need for her expansion, an expansion at a higher gear and higher standard. Physiology is necessary in all spheres of life,—private or public, social, economic or political, civil or military, both for defence or offence. Physiology plays an important part in the maintenance of health of an individual or of a community. Physiology can indeed add to the wealth of a country *e.g.*, by increasing the food production.

This is the reason for which Physiology has earned a special place in several free countries of the world—where people engage themselves in her study from different out looks *e.g.*, Plant Physiology, Physiology of Aviation, Physiology of the divers for work at the bottom of the sea, Physiology for the workers in the mines, factories, mills etc. save and except Physiology for the study of medicine. We find only the last in India. This is why India demands today considerable expansion in this respect.

Not to speak of Physiology, at present there in demand from every quarter for development of free India and this requires money which has after all a limitation. India is a poor country and this is why there is always a constant tug of war to prove one's own subject more important and urgent than that of another. We cannot wait for this pull and push. I therefore propose to make a plan producing many more Physiologists with our existing resources and to give effect to it immediately. These services can be utilised without much delay for the enrichment of the country. This is possible by making provision for training for B.Sc. and M.Sc. course in Physiology in the existing Medical Colleges and by training technicians in polytechnics which should be started in at least one of every big metropolis. This will save the country from immediate expenditure of a heavy amount and at the same time the country will derive considerable benefit from these trained people. Other institutions where Physiology is taught may be asked to shoulder similar responsibility. General principles of Physiology should be taught in schools. University authorities must be strong and must examine if an institution is truly and fully equipped so far as teacher and appliances are concerned to train up students in the subject. In the mean time, the country's condition may be expected to be better and the people also will realise the importance of Physiological knowledge and the beneficial effects of the science in orienting the daily life. Sincerely speaking, I shall not be very wrong if I say that India to-day also does not possess adequate number of Physiologists who may be asked to run the number of institutions that need be established for the purpose. Hence I believe this is how we can carry out our plan to do real good to the country.

When in this way sufficient number of people have been trained in the subject and their services utilised for making the country self supporting with higher standard, there will arise automatically a question of raising their standards and real upgrading will come then and then only. At present what I think uppermost in my mind is to improve the existing conditions in the institutions where this subject is taught. Every Physiology Department must have a mechanic and a workshop and a technician. Any man who attempts to carry out a research work, must have felt their fundamental necessity. For example if a small screw of an apparatus is missing, the entire apparatus becomes out of work, the particular work under question stops and this state continues until a screw comes from foreign market which is a question of months.

Next step in upgrading would be selection of students for Honours and M.Sc. course in Physiology. Special conditions must be imposed which have to be fulfilled by a candidate before he could get admittance in such courses, so that only a limited few will be chosen who can actually help for the growth and development of the science as well as of the country. They will not merely study the subject to get a degree for entering the senior-clerkship in an office.

Unless people in general realise the importance of the subject which is possible only by giving practical demonstration of how one lives a better life depending on the knowledge of Physiology, there cannot grow a sense of competition to learn the subject more perfectly and there cannot be a growth. Upgrading by simple rules and regulation at a stage of the country when the mass is far away from realising the realities of life, can be expected to do little good to the country.

STATISTICAL METHODS AND NATIONAL PLANNING

(Section of Statistics)

5th January 1949: 10, A.M. to 1 P.M.

DR. U. S. NAIR, Travancore, Presided:

PROF. MAHALANOBIS, Opened the discussion.

Professor Mahalanobis remarked that he was only interested in initiating the debate at that stage, and gather the reactions of the statisticians present at the meeting. His world-wide travels during recent years in connection with statistical work at U. N. O. had brought him face to face with the varied uses to which Statistics have been put in different countries. He was greatly interested to know how useful this work could be made in India.

Narrating his experiences of the statistical work of Norway and the personal meeting with Professor Ragnar Frisch, he said that there, under planned economy they had been framing a parallel National budget (over and above the usual budget) by an elaborate method of social accounting etc. in terms of services, work and facilities available. The Treasury Budget which comes annually after a lapse of about six weeks is closely checked up with the National Budget above. Pershaps the smallness of the country of Norway to an extent facilitated this, but their zeal for statistics more than anything was responsible for this.

Professor Mahalanobis then related his experiences of Statistical work in Denmark under the guidance of the eminent statistican Tinbergen.

He had an opportunity of visiting Turkey during the celebration of the 25th year of their Central Organisation for Statistics and he was amazed to see the great strides statistics had made there.

Coming nearer home, he had the pleasure of being invited to Burma on the first anniversary of their independence. While the country was greatly handicapped because of acute shortage of scientific manpower, he was much impressed with the tremendous zeal and earnesteness with which they have set about their great task of National Planning under the able guidance of their Prime Minister.

Professor Mahalanobis confessed that he was rather alarmed at the rather slow progress of the economic set up in India, and the terrible waste of the money in furthering the 'grow more' food campaign in an unorganised way. By setting the pace of discussion he hoped he would get an opportunity of hearing, if the statisticians have a full realisation of what they are capable of giving to the country.

DR. BHAT.

As one greatly interested in the use of official statistics, he narrated some of serious gaps in statistics still existing in agriculture and other fields. While he deplored it he also asserted that the present Govt. was genuinely anxious to remedy this state of affairs. He hoped that Professor Mahalanobis would in the fitness of things give a lead in this matter.

DR. DESAI.

Speaking in his personal capacity he reported what he felt to be measures of false economy, and wished Govt. to make up its mind in this matter. Stressing on the importance of such studies as National income and expenditure, he urged that work on these lines in India should be linked up with the work of economist statisticians like Stone and others abroad.

MR. DANDEKAR.

He struck a new note by suggesting that it was high time that Govt. should realise, that new statistics should not be collected at prohibitive cost, and that a lot of useful work could still be done without adding to the number of statisticians or their field of studies.

MR. CHATURVEDI.

Referring to the broad question of economy of the transition period and the specific question of control, he emphasised that reliable statistics and not uninformed or interested public agitation should decide the question of the imposition of control and similar other economic questions.

Again he felt that statistics had a great role to play in the matter of quality control in Industrial products. He rather strongly felt that the remedy lay in the appointment of qualified statisticians and not pseudo-statisticians to solve these problems.

DR. RAMMURTI.

Describing his experiences of the lend and lease scheme he narrated the great usefulness of statistics in the progressing of work done under these schemes. He regretted that at the close of war this statistical progressing or 'achievement audit' has fallen into disuse. He would like to see it rehabilitated even in peace times.

He felt that in every province there should be a central bureau of statistics, to think of the general problems for solution and to set up specific organisations to tackle them after the objectives have been defined. The technique to be followed would largely be a matter of administrative convenience and the appraisal of the implementation of the schemes the duty of the central organisation.

MR. T. P. GHOSE, Calcutta.

Discussing the role of statistics in National Planning he said that to him it seemed that the key problem in planning was the budget. He deplored the paucity of financial statistics to study the different important aspects—methods of procurement of finance; seasonality of issue of loans, availability of currency, etc., etc.

DR. N. S. SASTRY.

Any scheme of planning would recognise the importance of proper distribution of the resources, and any such proper distribution would in the ultimate analysis depend on a good background of statistical information. When this is conceded, the role of statistics in national planning can be immediately appreciated.

Past experience had sometimes made him feel that the executive were often more anxious regarding overnight preparation of statistics—rather than the compilation of the proper type of statistics and their full exploitation. Even in the choice of personnel one did not feel quite sure that Govt. had always been anxious to get the real aid from scientific statistics.

PROF. THOMPSON.

Speaking on the necessity of laying the proper foundations of statistical planning he deplored the absence of a regional committee on the Index number of prices. This he considers to be a serious gap and feels such organisation is essentially necessry before prices are effectively controlled and any useful lead to planning can be given.

Speaking about statistics for appraisal of improvement in long term and short term plans, he stated, that sampling studies alone could offer a reliable figure in between the two stages, and as such should always be undertaken.

DR. A. C. MUKHERJEA.

Referred to some of the serious gaps in Agriculture, Economic and Industrial statistics and Trade and Financial statistics. He felt that unless these were substantially remedied no great achievement in statistical planning could be immediately secured. He also felt that the existing statistics in certain spheres, needed to be reorientated to fit in with the changed conditions. The broader questions of regrouping of industries and regrouping of countries were also problems that could be thought in this context.

DR. SHUKLA:

Speaking on the importance of statistics in national planning he deplored that the role of educational studies in national planning had not received its adequate share of notice. The government was however fully alive that any scheme of reconstruction in education, required correct and comprehensive statistics; and things have been on the correct move.

MR. G. D. MATHUR.

Stressed on the great need of a central statistical agency, to effect the necessary co-ordination of all statistical activities. Without this no great progress in statistical planning could be expected.

Dwelling on the rather important national topic of a scheme of rationalisation of payment in dollars—he said that before this could be ensured elaborate and careful statistics must be secured on national budget, national income, and national expenses.

MR. PENDHARKAR.

Commenting on the discussion he said that from the approach of Prof. Mahalanobis to the initiation of the discussion of the problem, it appeared he was asking for the methods the statisticians were going to use before he had defined the problem to them. He felt what was essentially necessary was first a proper definition of the object of national planning, and the statisticians could then legitimately try to define the sphere where development was most urgently called for.

Stressing on the organisational aspect he felt that what was most required for proper statistical planning—was co-ordination within departments of statistics and between departments of statistics and that organisations should build up from Province and extend to the Centre. It was perhaps unnecessary to emphasise the necessity of qualified statistical personnel, in the enumeration of the resources—fixing up the targets and auditing the achievements. The main function of statistics was to bridge the gaps where they existed in the scheme of planning.

DR. U. S. NAIR.

He urged, the most important thing for review in this discussion is the statistical organisation which would most effectively help national planning and not whether statistics was important in national planning. From his own experience in the matter extending over years, he felt that the present scheme of departmental statistics should be supplemented by energetic mobile squads who would be able to wipe of arrears of work, infuse new spirit and energy into the scheme of things, and bring about active liaison between departments.

PROF. P. C. MAHALANOBIS, Calcutta.

In rising to conclude the discussion Prof. Mohalanobis said that he was rather pained to find that people either connected with active teaching of statistics or directly engaged in carrying on project work, as in his laboratory, have not thought it fit to contribute their appropriate share in this discussion. General teaching work is an important aspect of national planning and as such he felt they had a legitimate contribution to make.

National planning as he visualised it, required the services of statistics at every stage—in defining the objective—in suggesting agency or administrative machinery. Strongly stressing on the rather unfortunate aspect of a conflict apparently existing between the needs of executive and actual statistical control, so often manifested in official routine work, he urged that all statistics should be interrelated with a view to attain the great objective of the raising of the standard of living of the common man.

Referring to a concrete instance he mentioned that John Deer & Company the premier tractor manufacturing concern in America had actually proposed to supply tractors to India in lieu of steel. He personally felt that the objective basis on which such a negotiation should be finalised was not the domain of the politician, scientist or economist, but the real purview of the practical statistician, whose role would be the proper rationalisation of the problem of allocation of resources leading to the optimum integration of operational activities.

Statistics he felt could have the widest sweep—and establish successful contacts with related groups. He also felt that whether in the domain of industry, education or village improvement the statistician had a clear duty—to formulate a programme and press it earnestly for government consideration. This alone would help the statistician to find his feet in the scheme of national planning.

CENSUS IN INDIA

(Section of Statistics)

Mr. M. W. M. Yeatts.

Mr. Yeatts, the Census Commissioner, commencing his talk remarked, that the problem of Population census in India has always come to be associated with the technique of country-wide counting. In the actual words of an unsophisticated old village officer, it is the baffling problem of 'catching every man, woman and child.' Viewed against this graphic background, no boubt the enormity of the problem of census in a country of the dimensions of India can better be imagined than expressed.

The problem of census according to him falls into three broad stages:—

(*i*) the setting up of the ideal,

(*ii*) the fixing up of the method,..

(*iii*) the process of test or application of the technique.

The ideal method to be employed in a country, naturally is largely governed by the conditions obtaining there. In a country like India, it is not difficult to convince, that the questionnaire method is admittedly unsuited. The enumeration process is therefore the only practicable method.

Till 1941, the Indian census, he observed, had followed the traditional method of *simultaneous* counting. This scheme of overnight information for the teeming millions had required the services in the past of about 2 million enumerators. With the discarding of this process of simultaneity in the 1941 census, it became possible to cut down the number of enumerators, to less than 1 million, even with a programme of 14 languages and 22 questions. This is no small economy, when it is conceded that nothing much has been lost by way of accuracy.

The total enumeration, tabulation, compilation and publication costs in Indian Census, Mr. Yeatts reminded, though reaching the round figure of 50 lacs in 1941, was merely a trifle compared to the 15 or 16 crores required for the census in America with a population level standing roughly at 1|3rd of India. This economy has only been possible, because of the very interesting fact that in India, a lot of the population count themselves. While the potentialities of this aspect of a 'Citizen playing the role of an observer', so widely different from the mercenary enumerator, has been very interesting and quite fruitful in the past, the limitation of such an economic role must not be ignored. A realistic limit would thus at once be set to an overburdened questionnaire, or to the unhealthy pursuit of 'details simple for the sake of details'. When again it is remembered that the problem of census is primarily one between the enumerator and the citizen—the need of simple questions, that would soundly filter through the enumerator and save the annoyance of the citizen would almost be self-evident.

The other important aspect to remember in this connection is that while the cost of enumeration is more flexible, the costs of tabulation always bear a direct relation to the population enumerated. The only effective way of controlling the costs of tabulation, therefore, is to cut down an unnecessarily long questionnaire. In the 1951 census—the first free census in India, it has been decided to reduce the number of questions from 22 to 12 only. This he admitted, is no doubt a bold innovation; and he was happy that the wisdom of this change has been generally accepted. In his own opinion, he would go even further and assert, that a country-wide information may be even profitably limited to the two most essential vital questions—age and sex only. On all other aspects, he felt more accurate, skilled and well-directed occasional enquiries, as and when need arise, would be more desirable.

Mr. Yeatts deplored what he believed to be the fundamental drawback in arranging a census as a sort of '10-yearly eruption'. It should mean to him, a continuous flow of essential information gathering, with frequent dips in the stream, to gather different essential details at different points of time. This he felt could be achieved only on the basis of samples randomly chosen, more or less on the old lines of the 1 in 50 samples' of Yeatt's tables. As a long term aid to providing the population, from which samples could be scientifically and easily drawn for survey, analysis and assesment, he emphasised the need of numbering the houses. This task fortunately had already commenced and was fast proceeding. The lines of logical future improvement, he firmly believed would therefore be to continue to progress on sample-study basis, by gradually stiffening the sample enquiries, both in the matter of accuracy and control and with progressive training of the citizen, the real custodian of the information.

DR. RAWWURTI.

Said that while he appreciated from the practical point of view the Census Commissioner's idea of sticking only to the universals in enumeration, he could not but deplore the extreme inadequacy of many of the details of national life—particularly so connected with labour in India. Suggesting improvement in existing information he urged the adoption in India of the international heads of classification of the means of gainful occupation' (1931 consus in India) to afford wider comparisons.

MR. PENDHARKAR.

Stressed the necessity of the objectives to be more clearly formulated before the 1951 census the first census in Independent India is undertaken. He also urged a more effective use of the method of sample surveys as aids to census information.

MR. DANDEKAR.

Spoke vehemently on what he felt still to be the crying need for improvement in Indian Census. He was rather amazed at the end to be told much of it had long been implemented.

DR. SHUKLA.

Expressed the opinion that though the question of cost in census operation was very important, he would not wish this to unnecessarily outweigh all other considerations.

DR. SHASTRY.

Wanted to inform the audience of the many remarkable achievements in mechanical aids offered by Tabulating companies to simplify and expedite the arduous tabulation and collation processes of the Census operations. He hoped that these would be utilised to the fullest extent available in Indian census.

PROF. MAHALANOBIS.

Remarked that he felt he could not think Mr. Yeatts too adequately for agreeing to shoulder the burden of the census work in India for a second decade. His services would be specially welcome and important in the first census of Free India. As far as he was concerned he had always urged the need of abandoning of the principle of 'simaltenous' counting and inaugurating a continuous mechanism to fill up the work of the intercensal periods. Through Mr. Yeatts unremitting efforts, the first has already been dropped, and Yeatts "1 in 50" samples which has been tabulated in statistical laboratory in Calcutta, has also paved the way for satisfactory progress in the second direction.

He also urged examining the question of what he called combined surveys, as he felt that in a vast country like India, the method had great possibilities.

He closed by referring to the work of the U. N. Population Commission and the U. N. Sub-Commission on Statistical Sampling, with the labours of both of which he has been very prominently associated.

EARLIEST INDICATIONS OF MENTAL DISEASES

(Section of Medical & Veterinary Sciences)

Dr. Nagendranath De, Calcutta, Opened the discussion.

It may be spoken in general with certainty that mental diseases do not develop in a day. It has often been said that such and such sudden mental shock produced mental discease in such and such person. Though such causal relation between a mental shock and a mental disease seems quite apparent in many cases, thorough investigation into the past history in most of the cases would show that the elements of the disease were brewing in the mind for a long time before the so-called mental shock came in and before the overt symptoms of a mental disease became manifest.

If we look with penetrating eyes into the pathology of most of the physical diseases, we find that what we call signs and symptoms of the diseases are nothing but the reactions of tissues of the body to some abnormal physical (including nutritional) condition or to the invasion thereof by micro-organisms from outside. Let us take the case of pneumonia. The exudative reaction of the lung alveoli to the presence therein of the toxin of Diplococcus pneumoniae gives rise to the signs of consolidation of the lungs. The cough is a reaction of the nervous mechanism to the presence of the exudate in the alveoli and air passages and the rise of temperature is the reaction of the thermogenic centre in the hypothalamus to the presence of the toxin in the general circulation. The signs and symptoms of most of the diseases can be looked upon in this way. There is no need to distinguish between the so-called physical and mental diseases. Just as the physical signs and symptoms are the reactions of the body to the various etiological factors so the mental symptoms are the reactions of the mind to the etiological factors of mental diseases. It needs to be made clear here that the mind reacts not only to mental factors but also to physical factors just as the body reacts not only to physical factors but also to mental factors.

This is how the origin of the various physical and mental symptoms can be explained. When we talk of diseases we find that they cannot be divided so easily into mental and physical ones. A disease is a conglomeration of symptoms. If we analyse the symptoms of any disease, be it a so-called mental one or a so-called physical one, we find that in each case some at least of the symptoms are mental and some physical. It is only on the preponderance of mental or physical symptoms that a disease is called either mental or physical.

What type of mental disease an individual is going to develop is not determined all at once. It depends on the way the individual is used to react in different psychological situations. In other words this is firmly connected with the personality of the individual which begins to grow right from birth. Careful observation of the reactions of different children to the various situations in life provides the indications by which one can determine which of the children are going to remain normal and which are going to develop mental diseases and of which type.

HYSTERIA

Hysteria is a disease which develops only on the background of hysterical personality. The different character traits which make up the hysterical personality do not develop all in a day. Indications of these character traits can be found in many of these persons from their early childhood. I shall cite only a few cases who showed these traits and who were later found to develop the disease.

The first is the case of a boy who showed too much suggestibility. There is no doubt every child is suggestive but this boy had too much of it. Once he was told that 'brinjal' is something which has no good qualities as the name in vernacular implies, it is no good taking that. From that day he could by no means be induced to take brinjal.

Another day he was told that physical exercise is good for health and every one should take exercise. From that day he began to take vigorous exercise every morning and evening and what was more interesting he would ask somebody to feel and test if he was becoming stouter every day and he would not be satisfied if that testing was done negligently.

A girl had much of dramatic tendencies which we call the centre-of-stage feeling. Once I happened to be with her when she was passing a road where many people both young and old were running towards and entering a lane. We did not know why these people were running. Soon afterwards a fire brigade car was seen to enter the same lane. So it was surmised that there must be fire somewhere in the lane though neither flame nor smoke could be seen. The girl on reaching her home began to say "I saw such a big fire, how high were the flames, I thought they were going to burn the whole city". Everybody in the house was surprised and was expressing awe and astonishment. I heard her telling the story and asked "Did you actually see the flames?" Then she did not answer my questions but only laughed and laughed and laughed.

MANNERISTIC MOVEMENT IN SCHIZOPHRENIA

Manneristic movements of schizophrenia may be of any kind involving any part of the body. In most cases we do not know what they mean because by the time they are manifest the patent becomes uncommunicative. In very rare instances only we find cases where manneristic movements are developing and yet the person remains communicative. In these rather exceptional cases only we can find some clue to the origin of these movements.

A young man of about 26, who was still working in a factory, was sent to me with a note from his office master that in the midst of his work in the factory he makes fanning movements of his hands which were rather unusual and he was also found to make some tapping movements on the machinery which were not consistent with his work and might prove dangerous to his life. When I saw the man I saw the movements of his hands they were not of fanning himself but of fanning away something. He was still communicative and after gaining his confidence I could bring out the following story from him. He had often had phantasy of sex but when the phantasy had reference to some near relative specially a respected one like the mother, he tried to drive those thoughts away by those movements. The tapping movements on the machinery he explained was due to the fact that when he thought of any person the movements usually carried but by that person came on him. One of his friends was a player on musical instruments (tabla) and whenever he thought of him, the latter's movements of playing the instrument came on him though he never consciously wished to do so.

A young man of 20 was found while walking to make pushing and squeezing movements with hands against air, which were interposed at times with running the flat palm of his right hand swiftly from above downwards just in front of his face, chest and abdomen. On investigation it was found out that the apparently pushing movements were really pressing movements on the breasts of women in his phantasy and when the phantasy turned towards his own mother he checked it and tried to tell himself "No, no, do not think like that, she has no eminences it is all plain like this", the swift movement of the palm of his right hand in front of his body was meant to indicate this.

Another youngman was found to pass his hand round any prominent thing on his way and also to make occasional kicking movement while walking on the street. He was found to be a strong passive homosexual and had the obsession that anything with sharp or even a blunt point may run into him and when passing his hand on them he was only trying to console himself that they were not passing in. When he saw anybody with a prominent nose the point of the nose aroused similar thought in him and the kicking movement was done to kick that nose out in phantasy.

R. B. DAVIS, Ranchi.

(Demonstration of Rorschach Testing)

As Medical students we were taught that the clinical examination of the patient is of more value than any laboratory tests in evaluating a case, and of the clinical examination a thorough history-taking is the most important part. The same solds good in Psychiatry as in General Medicine. In fact, obtaining of thorough and detailed information from the patient's relatives is, perhaps, the most important factor in making a psychiatric diagnosis. Apart from the history, it goes without sayting that a complete physical, and particularly neurological, examination must be made. But in many patients coming for the first time to a Psychiatrist, the physical examination is negative in all important respects, and our main work of examination is to investigate the patient's mind. Again, the purely clinical aspect of day-to-day contact between the patient and the Doctor, in conversation and observation of the patient's behaviour, assisted by reports from psychologically trained Nurses and psychiatric social workers, is all important. As in General Medicine, in Psychiatry the results of the clinical examination are supported and checked by certain laboratory tests—in this case, psychological tests. Included among these one might mention the revised Binet-Simon Intelligence Test, the Matrix Intelligence Test, the Weischler Scale which is a general psychometric test, the Shipley-Hartford Test and the Babcock Test which are primarily used in differentiating between organic and psychological mental disorder, the Word Association Test, which is helpful in elucidating the underlying psychopathology of mental disorders, and various personality inventories.

You will notice that I have not included the Rorschach Inkblot Psychodiagnostic Test in this list of psychological laboratory investigations. This is because I consider that the Rorschach Test should be part of the clinical examination of the patient and should be performed by the Psychiatrist himself who is responsible for making the diagnosis, just as in General Medicine, the Physician himself uses an Opthalmoscope, a Stethescope, a Patella Hammer and a Sphygmomanometer to assist him in his clinical methods of examination. Before dealing in detail with the Rorschach Test, I would like to mention one other clinical method which shauld be used in the same manner. This is the evaluation of the patient's unconscious mental processes by means of injections of an intravenous Barbiturate, such as Pentothal or Amytal.

In the Rorschach Test, the patient is shown a series of specially selected Inkblots and asked to describe what things they look like to him. The Test evaluates the quality and quantity of the patient's mental association processes. It gives very accurate information as to the method of working of these processes, and readily picks out any defect resulting from a generally disordered state of mind. I think it would be of interest to the audience if I were now to demonstrate the administration of this Test. In a minute I am going to ask one of the members of the audience to volunteer as a subject. I will not, however, attempt here to score the result given, as the scoring and its results give such penetrating information that it might be embarrassing to the subject for it to be made public. The actual responses to each card, however, do not give anything away until they have been thoroughly evaluated.

I shall now demonstrate my own method of scoring and evaluation which is based on Devid Rappaport's Psychodiagnostic Testing on the responses given by a subject previously tested.

The administration of the Test was then demonstrated on a member of the audience. Following this, the response records of a mental patient were shown on the screen, and the method of scoring was demonstrated in a very general manner. The following points were emphasized:—

There are six scoring categories: ((*a*) The area chosen; (*b*) The determinent; (*c*) The form level; (*d*) The form quality; (*e*) The content; (*f*) Miscellaneous.

(*a*) *The area chosen.* This score depends on whether the response involves the whole blot, a considerable portion of the blot or a minute portion of blot, or a space surrounded by the blot. The whole is scored "W", a large portion is scored "D", a minute portion is scored "Dr'', and a space is scored "S".

(*b*) *The determinent.* This depends on what particular feature of the blot led to the response. If it is merely a question of the shape, the score is "F", *e.g.*, the blot on Card I is the shape of a Bat. So this is an "F" response.

Responses given solely on account of the colour of the blot are scored "C", *e.g.*, 'Blood' on Card II. Combinations of form and colour are scored "FC" or "CF", according to which is predominant.

Responses determined by dark shading are scored "Ch" or "K". This may be combined with "F", in the same way as "C" responses.

Human figures in movement are scored "M".

(*c*) *The form level.* This depends on the actual resemblance or congruity between the blot and the response. According to the level of congruity, it is scored. $+ \pm \mp -$

(*d*) *The form quality.* This score depends on the type of form concept given. Vague responses are scored "Fv", *e.g.*, Clouds, Bones. Ordinary responses are scored "Fo", *e.g.*, a Bat, a Bear, two Men.

Highly organised, good responses are scored "Special F +'', *e.g.*, Card VIII—"A scene in the polar regions with a Polar Bear climbing up to the peak of an iceberg." Similarly, highly organized responses which, however, differ considerably from the actual blot are scored "Special F—".

(*e*) *The content.* This category is self-explanatory. Animal responses are scored "A", human "H", anatomical "At", etc.

(*f*) Various *miscellaneous* scores are placed in this category. A response is scored "P" if it is a popular response of the type generally given by most people.

"Orig." indicates a very unusual type of response which is hardly given by anybody.

"Affect" indicates an emotional reaction on the part of the patient when giving the response, *e.g.*, Card IV—

"Something frightful-looking with tusks and eyes."

"Sel-ref." indicates a self reference response, *e.g.*, Card II—"Somebody has wounded my body and blood is coming out."

Finally, in this category also are placed the more pathological indications. Absurd, queer and confused responses are scored as such. A score of "confabulation" indicates an indulgence in fantasy, quite divorced from the appearance of blot.

Let us describe briefly the significance of different scores.

First—the number of responses. The average number is 24. Too few responses indicate a depression, retardation or organic dementia. Failure to respond on 5 cards or more is, by itself, an indication of some mental disorder.

Increase in the number of responses, if the record is otherwise normal, indicates good intelligence and plenty of imagination. The number is also increased in certain conditions of mental over-excitement.

Secondly—as regards the area chosen. The average is about 46% of "W" responses, 47% of "D" responses and 4% of "Dr" responses.

A high proportion of "W" responses, if a record is normal and the responses are good, indicates a high level of abstract intelligence, ability to integrate and powers of leadership. On the other hand, many "W" responses in an abnormal record with poor form level is one of the indications of Schizophrenia.

A high proportion of "D" responses and particularly of "Dr" responses indicates a rigid, meticulous, obsessive type of personality, and the "W" responses are few, if not absent, in states of anxiety.

"Space" responses tend to occur in cases of paranoid state. These patients are perverse. They look at things in a different light from other people, and they respond to the inner space of a blot instead of to the blot itself.

Thirdly—the proportion of different determinents. The average is about 60% pure form responses and 78% including also mixed "F" responses with "F" predominant.

The proportion of pure "F" is increased in depression, anxiety and retardation. It is decreased in imaginative, artistic subjects and, in some cases, of Schizophrenia. The number of additional mixed "F" responses is a good indication of mental balance. A complete lack of "FC" indicates mal-adjustment, whereas a high number of "FC" indicates a well-adjusted personality. Responses with "Ch" predominant indicate anxiety, but "F Ch" scores are comparatively normal. Movement scores, *i.e.*, human figures in movement scored "M", are an indication of good social adjustment and an active mind. Movement and colour should be well balanced. A high colour score with no movement is common in Schizophrenia.

Fourthly. The form level is very important as a Schizophrenic indicator. A high proportion of scores with + or $\underline{+}$ indicates that the subject is, to some extent, in touch with reality, but if the proportion of + and $\underline{+}$ scores is below 40, it means that the associated processes are grossly disordered due to a psychosis such as Schizophrenia. The form level tends to be very high, 90% or more in patients suffering from Obsessional Neurosis. They have an obsession to fit their responses exactly to the blot and they will not allow themselves to deviate on any card. The average normal form level is about 75%.

Fifthly, as regards form quality, "Fv" (vague form) indicates anxiety. The subject is afraid to give any but very vague responses. A high proportion of "Special F+" is an indication of good intelligence. A mixture of very good form responses scored "Special F+", and very bad but elaborate form responses, scored "Special F—", is a Schizophrenic indicator.

Sixthly, concerning the content. A large number of animal scores indicates a dull mentality. Animals are the easiest figures to make out in the blots and they are given by dull, depressed, anxious, retarded subjects, whose minds are not lively enough to produce very much variety. A good number of "human" responses on the other hand indicates a lively and active mind and good social adjustment. Massing of anatomical responses sometimes occurs in Schizophrenia, in Involutional Depression and in normal subjects who have a medical training. Responses referring to sexual organs are of pathological significance if they occur in a person who is normally reticent on these matters. However, they are quite common in a normal setting with the modern, uninhibited type of individual. Responses referring to the anus are almost always of some pathological significance.

Seventhly, as regards the score of "P" (Popular). Certain responses on certain cards are found by experience to be given by a majority of normal subjects, *e.g.,* two Bears dancing on Card II. A complete lack of Popular responses in quite common in Schizophrenic subjects who have a tendency towards the bizarre in their associations. As we have seen in the case of the form level score, a satisfactory number of Popular responses indicates that the subject is in good touch with reality, and that he is not suffering from any deep-seated mental disorder. The number of original scores is high in Schizophrenic and highly intelligent subjects alike. It is low in cases of anxiety and depression, and in certain other cases of Schizophrenia where retardation is a prominent symptom.

Finally, the whole record is given two further scores.

First, the Perseveration Factor. This is the percentage of scores out of the whole which are identical with other scores, *e.g.,* out of a total number of responses of 10 the subject gives two "Bat" responses and three responses of "Pelvis". In this case, therefore, the Perseveration Factor is 50%. The Factor is high in anxiety, depression, retardation, chronic dementia and particularly in epileptic psychosis and mental deterioration. Even patients being treated with Convulsive Therapy which, of course, is the equivalent of epilepsy, tend to give a high Perseveration Factor.

Secondly, colour shock. This is indicated by the presence of some unpleasant emotional response on the part of the subject to the coloured cards. The person will say. "Oh Doctor, I find these colours so confusing" or "Oh dear, look at all those colours," This feature is merely noted as present or absent. When present, it is an indication of repression and particularly of hysteria.

You will see how useful this Test is in a country like India where there are so many different languages and dialects. It depends very little on the shades of meaning of words. It can very easily be performed through an interpreter with minimum distortion, because the responses are easy to translate, being concrete concepts. In the demonstration of scoring and evaluation, I have only touched on a few of the factors which indicate abnormal functioning of the mind. There are many others which I have not had time to mention, and the Test is one of the most useful in detecting early mental disorder and mal-adjustment. It is of particulr use in Child Psychiatry and the question of its application to children is a subject in itself.

DISCUSSION

H. STUART,

How is the Rorschach Test validated, *i.e.,* how are the norms established?"

DR. DAVIS,

Rorschach originally applied the Test to about 1,000 mental Hospital patients, and the variations in the different scores were found to occur in accordance with the clinical diagnosis as I have described. More recently, Rappaport has worked out the norms for a series of 54 normal controls drawn from the City Police in an American City.

A. SANGHI,

Language will make a difference in answers. Should mother tongue only be used in preference to other languages?"

DR. DAVIS,

Language makes less difference in the administration of this Test than perhaps any other psychological test, except the purely Manual Ability Tests. The Test should be administered in the mother tonque of the subject, and this can be done very successfully with the help of an interpreter. The administrator of the Test himself, however, need not know the language of the subject, because once a rough translation has been given the subject can be asked to point to the features of the blot which he is referring to, and it is comparatively easy for the administrator to see exactly what the subject means without understanding his language.

S. K. MITRA, Calcutta.

How do you interpret K responses?"

DR. DAVIS,

Originally Rorschach scored the dark shading response as "K". In Rappaport's notation, which I am following in this paper, these are scored as "Ch", short for Cheiroscuro. Pure "Ch" and "Ch F" in appreciable numbers is an indication of anxiety.

Col. P. N. BARDHAN, Bangalore.

In Psychiatric practice a number of reactions are encountered. Do these tests have an application in their handling? Is there a way of determining whether genuine answers are being given?"

DR. DAVIS,

The Rorschach Test has its chief application in determining the type of psychiatric reaction with which we are dealing. Perhaps its greatest value is in differentiating between Schizophrenia and Anxiety State or other Psychoneurosis. This is of supreme importance because psycho-analysis, which may be of great value in a psychoneurosis, may do harm in early Schizophrenia. As an example of the value of this Test, a man recently brought his brother to Hospital for admission as a Voluntary Boarder. He described some of his brother's behaviour in the recent past which seemed like the behaviour of a Schizophrenic, but when I examined the patient I could find no apparent disorder of thought, hallucinations, delusions, etc. The patient appeared to be perfectly normal mentally. I was beginning to doubt the brother's bona fides. However as a routine, I applied the Rorschach Test. The result of this showed every indication of a Schizophrenic psychosis, and I was therefore quite prepared to admit the patient to Hospital. Unfortunately, after a short time under observation, the patient was showing every overt symptom of typical Schizophrenia. In this Test there are no correct or incorrect answers. If a subject were attempting to malinger giving many obsiously absurd responses, this could be spotted at once.

M. P. MEHROTRA, Ahmedabad.

Does Education make a difference in the evaluation of the test?"

DR. DAVIS,

Certainly. The Test if of very limited value in totally uneducated and totally ignorant subjects, *i.e.*, subjects without even primary education. In any case, with this type of subject, the only psychological tests which are of much value are the very simple Manual Ability Tests.

A. EDWIN HARPER, Allahabad.

Has the Rorschach Test been adjusted to Indian culture?"

DR. DAVIS,

No. This is a task for Indian Psychologists.

D. L. SHARMA, Tatanagar:

The test is useful and should be standardised, but instead of going purely by the numerical values of each type of response, a whole picture of the individual should be obtained. This test is a measurement of temperament or emotional life, and does not differ with people of varied intellectual level. At Jamshedpur, this test has been given to a small number of Industrial workers to get a general picture of their mental make-up.

DR. DAVIS,

I agree that it is the general conformation of the Test result that matters rather than any individual numerical value; but on the other hand, the application of this test certainly differs markedly with people of varied intellectual levels. Unless one takes into account the intellectual and cultural background of the subject, the Test is quite valueless. For instance, a perseveration of anatomical responses may be quite normal for a Medical man, whereas it may indicate a gross mental disorder in somebody else.

S. S. SYALEE, Lucknow.

What is the time given for each card?"

DR. DAVIS,

The important time factor is the time which elapses from when the patient is shown each card to when he makes his first response on that card. This is noted in the record. It may vary from two or three seconds on each card for Chronic Schizophrenics who tend to plunge impulsively into a poorlyconceived whole response, up to about two minutes for retarded, depressed individuals. The average latent period is about 15 seconds. A markedly delayed response on one card has the same significance as a delayed response in the Word Association Test. It means that some feature of the card has disturbed a repressed complex.

I. THE IMPORTANCE OF ECOLOGICAL STUDIES OF PLANTS IN AGRICULTURE.

(*Sections of Agriculture and Botany*).

DR. R. S. VASUDEVA, New Delhi, Presided.

G. S. PURI, Dehra Dun.

Strictly speaking, agriculture is nothing more nor less than applied plant ecology: For successful agriculture, therefore it is highly important that ecological studies (especially aut-ecology) of crop plants and weed flora be undertaken. These studies should aim essentially at finding out food requirements of plants and the capacity of the soils to supply the required minerals, etc. The relation of plants and soil is dynamic in nature, therefore, agricultural operations should be periodically adjusted to derive the maximum benefit from the soil without in any way reducing its fertility. The application of fertilizers (preferably organic manures) is therefore, a necessity.

The appearance of weeds in a crop is a natural sign of hunger in a social and its remedy does not lie merely in physical or chemical destruction of weeds but in improving the soil complex so that it becomes more suitable to crops than weeds. There is no dearth of land in our country and the choice of crops is almost unlimited; the only thing which is needed is ecological knowledge, so that the right variety of crop be grown on suitable type of soil. For this, an ecological survey of the soils of India is almost a necessity and may be undertaken as a part of the "grow more food campaign." As suggested by me to the ministry of Agriculture in 1947, an early establishment of Ecological survey of India for conducting researches in applied plant ecology in relation to forestry, agriculture and soil conservation, will doubly repay the amount of money invested in this department which is of such a great national importance. Ecological survey and assessment of soil fertility is greatly facilitated if geological structure of the area and composition of parent rock is known. The status of soil fertility on dip and scarp slopes, in accumulation areas, at different elevations on a valleyside will be different. For example, it would be dangerous on ecological grounds to have agricultural land on scarp slope or on top of a slope, which must be kept under a forest. Otherwise, it would initiate erosion of land—a phenomenon which is already threatening the organised agricultural life in some parts of our country.

(Rest of Discussion on this topic is not available.)

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CALCUTTA —Published by the Indian Science Congress Association, 1, Park Street and Printed by A B Saha at Manohar Printing Press, 4, Kyd Street, Calcutta—16

I. A. R. I. 75.

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